POWER

Volume 51 **New York, February 10, 1920** *Number 6*

GONNA!

By Rufus T. Strohm

There is nothing that's so easy as a promise,
As it only takes a little word or two,
But it's different when Harry, Dick or Thomas
Is compelled to make the pesky thing come true;
For it's something of a job to shift the tenses
'Twixt the simple phrase "it will be" and "it was,"
And it isn't very long before he senses
That the man who's always "gonna" never "does."

When you find a fellow-mortal strong on talking
Of the things he'll do tomorrow, it's a cinch
That you'll find him quoting alibis and balking
When you come to test his courage in the pinch;
For the fellow who's extravagantly gabby
Has a cranium that's filled with fluff and fuzz,
And the mainspring of his will is weak and flabby,
Since the guy who's always "gonna" never "does."

Have you noticed how the bumblebee resembles
Certain fellows you have happened to espy?
How the overarching welkin throbs and trembles
When this fat self-advertiser lumbers by?
Yes, his disposition's lovable and sunny,
But his days are largely spent in noisy buzz,
While his labor yields a minimum of honey,
For the dub who's always "gonna" never "does."

When you've got a task to finish, go and do it!
Don't procrastinate until the morrow's sun.
Save your breath to give you pep to struggle through it;
There'll be time enough for talking when it's done.
Look at Job—he had a grand excuse for blowing
As to how he'd raise a ruction there in Uz,
But he lived in patient silence, wisely knowing
That the chap who's always "gonna" never "does."

Moline Station Adds to Steam and Generating Capacity

By THOMAS WILSON

New Boiler Installation with a Number of Interesting Features Housed in Building of Reinforced Concrete Throughout—Large Beam and Column Construction with Brickwork Filling in the Panels in the Side Walls

OWING to the rapid growth of the community embracing Rock Island, Moline and Davenport, an ideal location for various industries, the demand for power has grown in proportion. For the last five years the load on the big generating station of the United Light and Railway Co. has increased approximately 30 per cent. per year. In 1913 a 10,000-kv.-a. turbo-generator had been installed. Three years previously a 6000-kw. turbine had replaced an engine unit, and in addition there were some smaller turbines, giving an aggregate capacity of 21,500 kw. The turbines mentioned, having the old rating, were good for at least 50 per cent. overload. In 1916 it was found that this equipment would not be sufficient to meet the growing demand and that arrangements must be made at once to add both to the steam and the electrical capacity of the big Moline plant supplying the entire community.

Considering the present load, the plant was situated practically at the center of distribution, but the area of the site was limited, making difficult extensions requiring additional space. Rather than a new plant in another location, a way was found to make modern and economical additions to the present station. On this basis a 20,000-kv.-a. turbo-generator was ordered to replace some of the smaller and less efficient units, as had been the custom in the past, and space was found for a new boiler house containing at present three 1003-hp. Stirling boilers to serve the new turbine, with space for three more boilers of the same type for a future 25,000-kv.-a. unit. As outlined, these plans seemed to be the ultimate limit for this particular plant, and probably will take care of requirements for five years.

Reinforced Concrete Construction Adopted

Building a boiler house during the war period, when structural steel was at a premium and extremely difficult to obtain, necessitated plans other than standard. A decision was made to construct a building of reinforced concrete throughout. The materials required were more readily available, and according to estimates, the initial cost would be less. Laying out the boilers in two rows of three each, facing toward a central firing aisle, called for a building 82 ft. wide by 102.5 ft. long. A basement with a headroom of 18 ft. was provided, and it is 40 ft. from the boiler-room floor to the main roof. This gives just the desired clearance over the boiler tops, and there is no surplus building space. At the same time good light and ventilation are obtained by large window areas near the floor and roof lines in all elevations. By a patent operating device the windows are operated in sets, so that the openings are spaced at uniform intervals and the amount of air circulating in the room can be regulated closely.

The building and the roof proper are of simple column-and-beam construction, with the usual brick walls filling in the panels. Fortunately, the columns and foundation walls rest on solid rock, so that no expensive footings, such as might have been required by the immense concrete columns, were needed. In designing the structure, no attempt was made to attain architectural beauty at additional expense. The plant is situated where it is not readily observed, and the main objects were maximum capacity and efficient and convenient operating conditions at a minimum investment. Originally, the designer contemplated using a pilaster and elaborate brick cornice effect. As a final summary it was found that money could be saved by leaving the concrete columns and beams exposed, and using brick simply to fill in the panels. This construction presents a neat and substantial appearance and serves the purpose admirably. The roof proper, consisting of long-span hollow tile, covered with concrete, is supported by reinforced-concrete beams 14 in. wide by 38 in. deep.

Large Bunker Capacity Required

Because of irregularity in car service and limited storage facilities in the yards, an enormous bunker was designed to hold 10 tons per lineal foot, giving a total bunker capacity exceeding 1000 tons. It was erected over the firing aisle and, like the boiler room, has no waste space. The bottom of the bunker was located at a height that would permit drawing the tubes, and this came at an elevation that made it possible to support the main roof beams on the large concrete columns erected primarily for the bunker. Continuing this simplicity of construction, the bunker was made rectangular, the slopes required at the bottom to prevent dead pockets of coal being obtained afterward by means of cinder fills, as indicated in Fig. 4.

Concrete girders having a span of 25 ft. over the boiler fronts support the dead load of all the upper bunker construction as well as the coal in the bunker. The girders are 3 ft. wide by 9 ft. deep and are heavily reinforced. The main bunker columns, 18 x 50 in. in cross-section, have been placed at the front corners of the boiler settings and arranged to give maximum aisle space between boilers, the narrow dimension of 18 in. being crosswise with the boiler. To cut down the unsupported length of column, 40 ft. from floor to roof, a concrete strut is provided at mid-span between the columns on opposite sides of the aisle. In reality the two elements are a split column acting for a single purpose.

As the depth of coal in the bunker may approximate 30 ft., a considerable pressure on the side walls would be possible. To avoid using walls of extra thickness, vertical concrete columns were designed as beams to take this bulging action, so that the panels between, ranging from 14 to 16 ft. wide, could be filled with comparatively light brick construction. This design tended to keep down the dead load and, as it harmonized with the construction of the main part of the building, gave a more pleasing appearance than would walls entirely of concrete, which at one time were considered. At the bottom the bunker is made up of concrete slabs 8 in. thick and having a span of 6 ft. 3 in. These slabs are supported by concrete beams, 18 x 58 in., having a span of 19.5 ft. across the firing aisle and supported on the

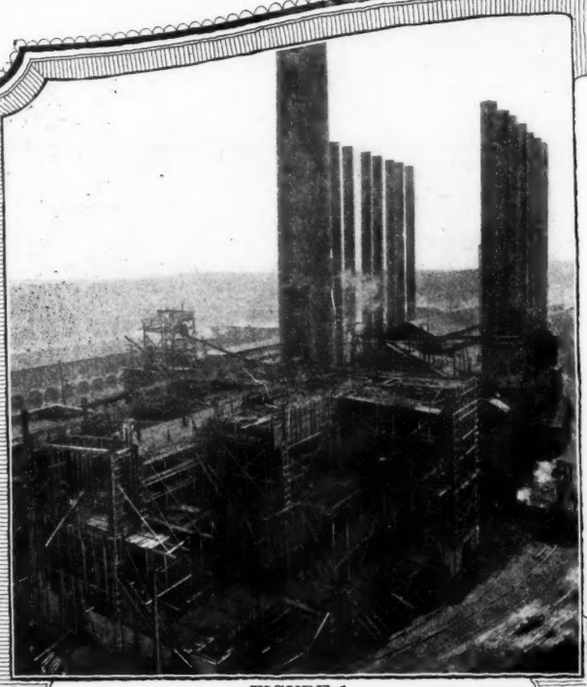


FIGURE 1

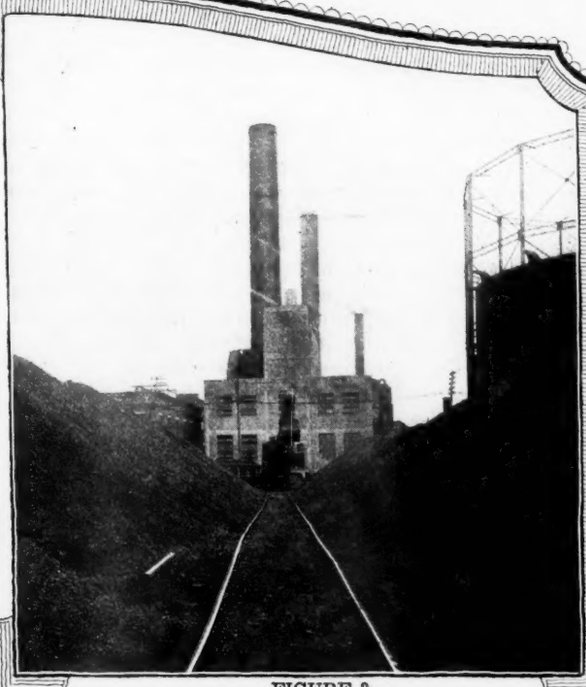


FIGURE 2

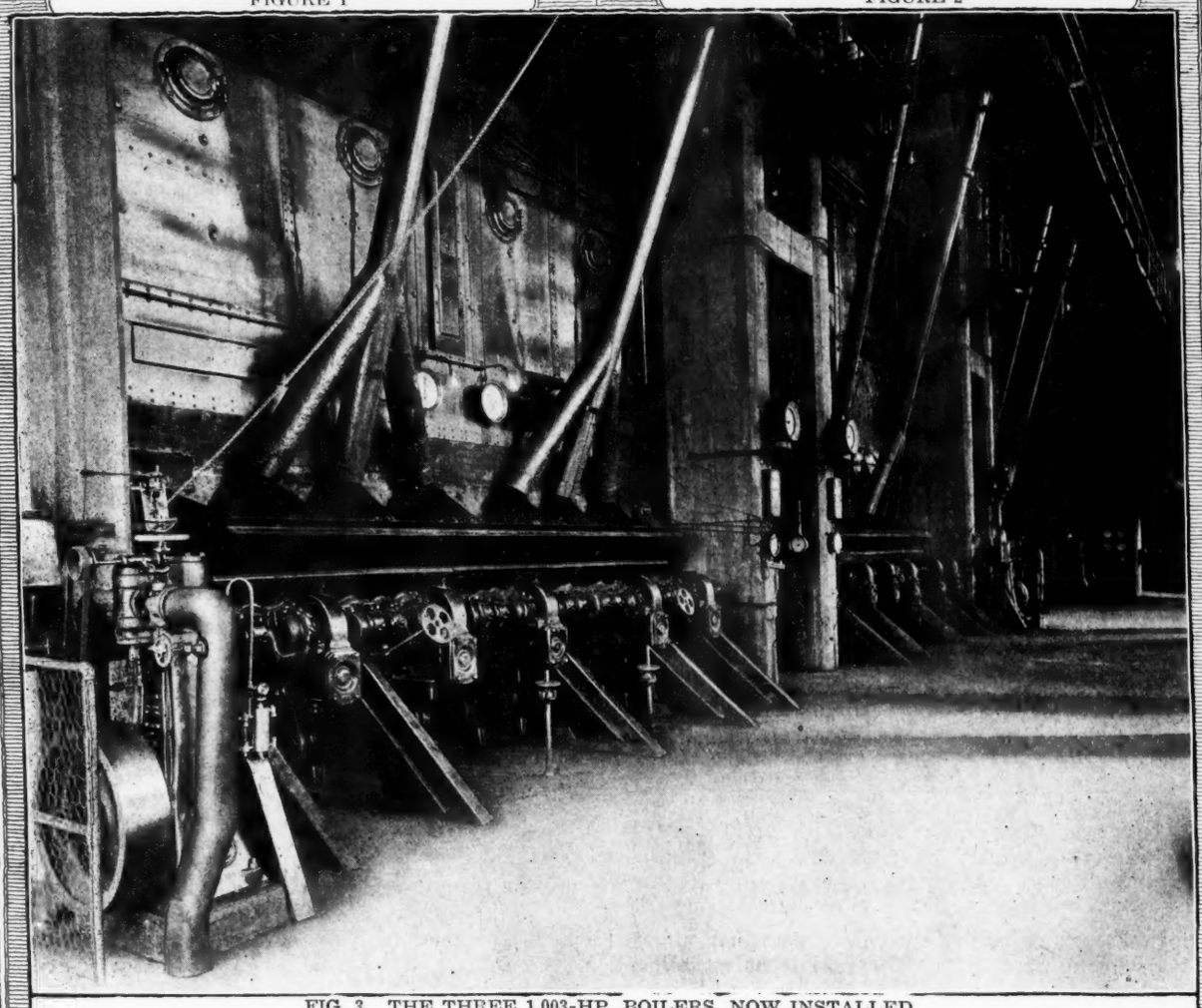


FIG. 3. THE THREE 1,003-HP. BOILERS NOW INSTALLED

FIG. 1. NEW BOILER HOUSE UNDER CONSTRUCTION, SHOWING IMMENSE AMOUNT OF FORM WORK
FIG. 2. EXTERIOR VIEW OF COMPLETED BUILDING

main concrete bunker girders previously mentioned. To avoid the undesirablity of having acid water from the coal permeate through the bottom of the concrete work, as had been the case in another plant of the company, it was decided to cover the lower sections of the bunker with a membrane waterproofing consisting of three independent layers of asbestos felt, secured together and to the initial concrete surface by layers of hot asphalt waterproofing cement. This treatment, applied to the top side of the slabs, and protected by brick, has given satisfaction.

At the operating-floor level of the bunker plenty of light and ventilation have been provided by rows of windows along either side. This arrangement gives ideal working conditions for the men having charge of the conveying equipment in this part of the plant. As is customary, the bunker is subdivided and each compartment has a gage at each corner, spaced in feet, so that the operator can determine the depth of coal in the bunker and, from a chart which is furnished, translate this depth into tons of coal. As the coal passes through a crusher before entering the bunker, it is of fairly uniform size, so that the initial calibration will remain reasonably accurate for the different grades of fuel that may be used.

At present the boiler room contains three units, each having 10,032 sq.ft. of steam-making surface and sufficient area in superheating coils to maintain a superheat of 125 deg., the operating pressure ranging from 200 to 225 lb. gage. These boilers will supply the new 20,000-kv.-a. turbine, which, at normal rating and 80 per cent. power factor, will deliver 16,000 kw., so that the ratio between boiler horsepower and kilowatt generating capacity is 1 to 5.3. This ratio is perhaps a little higher than the average, but the boilers may be operated up to 300 per cent. of rating. On the other side of the firing aisle every preparation has been made for the future units, so that their installation will be comparatively simple.

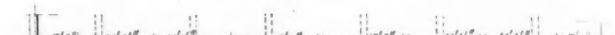


FIG. 5. PLAN OF BUNKER, SHOWING CONCRETE COLUMNS IN SIDE WALLS AND SUPPORTING GIRDERS

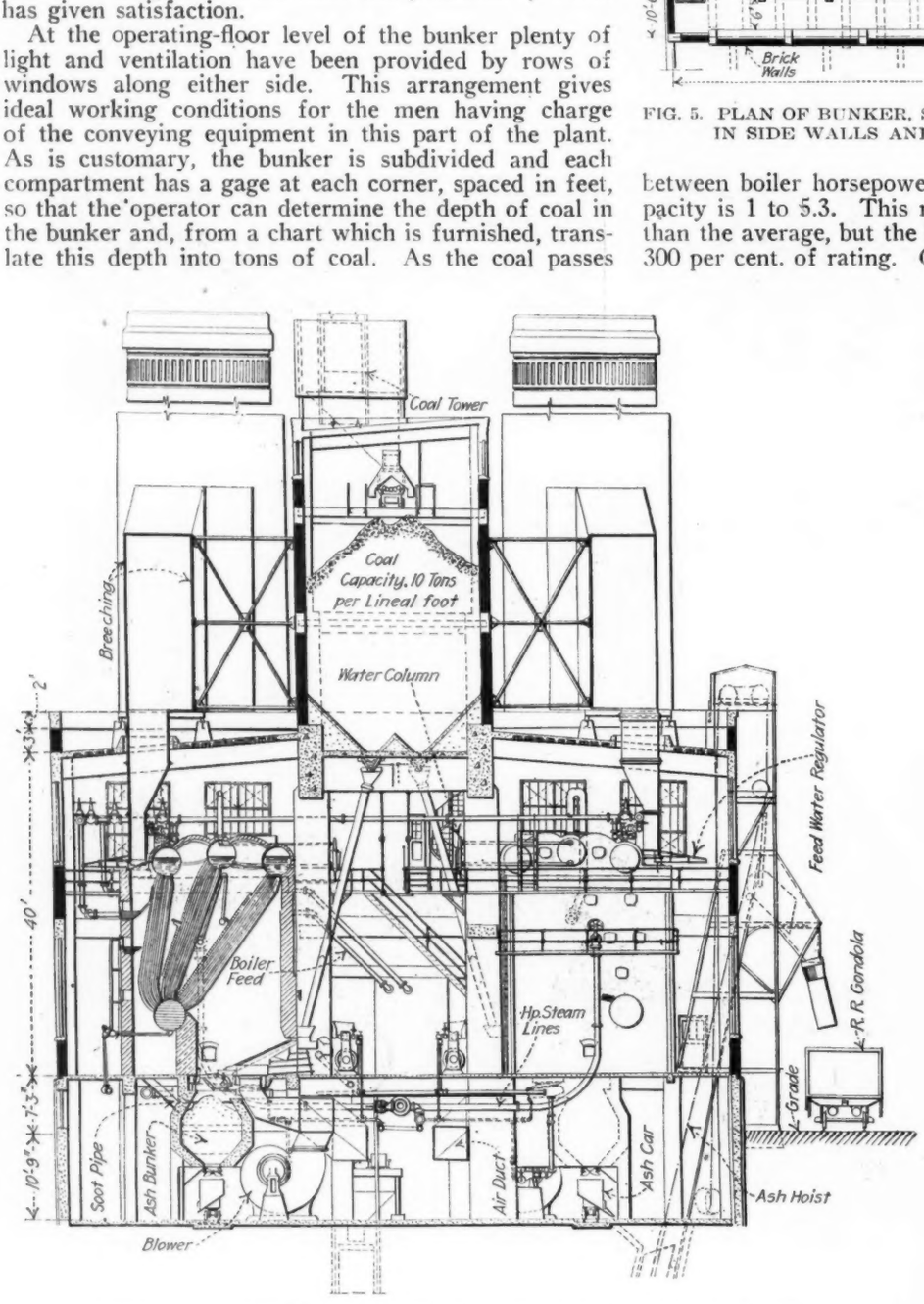


FIG. 4. TRANSVERSE SECTIONAL ELEVATION OF BOILER HOUSE

Each of the present boilers covers a floor space 23 ft. 6 in. wide by 21 ft. 1 in. deep, an area of 496 sq.ft., reducing to 0.5 sq.ft. per horsepower of boiler rating. From the floor to the top of the steam opening the distance is 26 ft. 6 in. The center of the mud drum is 7 ft. 6 in. above the floor line, an unusual height. Reference to the sectional view of the plant will show that there is no arch construction over the underfeed stoker serving the boiler, so that a straight front wall provides a furnace of large volume. High-grade firebrick laid in high-temperature cement line the front walls and the side walls back to the first pass. The balance of the brickwork in the setting is according to standard practice.

To guard against excessive radiation, the side walls back to the first pass are covered with insulation attached to ⅜-in. V-ribbed wire lath anchored to the walls by use of ⅜ x 2½-in. lagscrews, and expansion shields properly placed. Over the lath is applied a ½-in. thickness of No. 302 plastic asbestos cement, then 1 in. of No. 400 plastic asbestos cement, followed by poultry netting, over which is another ½-in. thickness of cement covered by a 6-oz. canvas jacket. The lower portions of the settings along the aisles between boilers are also protected.

Each boiler is equipped with a 22-tuyere underfeed

stoker, with extension grates and power-operated dumping mechanism. The stoker is driven by a vertical engine on the boiler-room floor, connected to the stoker through a jackshaft in such a way that it is possible to use two gear ratios. When operating at low rating, the smaller ratio is used, but at periods of overloads the gears of higher ratio are brought into action by means of a clutch. These provisions have been made in addition to the usual regulation of engine speed. Normally, the jackshafts are independent of each other, but in case of an engine failure may be linked together, so that the engines of the other two units may drive all three stokers. This entails operating all stokers at the same speed, which is not considered desirable, but is better than facing the possibility of shutting down an entire boiler unit of large rating, owing to failure of the drive.

Immediately under each stoker is a forced-draft turbine-driven fan, having capacity to supply sufficient air to operate the boiler at 300 per cent. of rating. Although each stoker has its individual unit, connections are made between the air ducts of adjoining stokers, so that it is possible to operate three boilers on two fans during periods of shutdown of any particular unit.

One of the interesting features of the plant is the outside breeching mounted on pedestals supported by the roof beams, which were made heavy enough to take the additional load. The present breeching accommodates the three boilers now installed, and there will be a similar breeching on the other side, for which the foundations have been prepared. Either breeching will be served by a concrete stack 16 ft. 6 in. inside diameter at the top, and 238 ft. high from the base, which is 20 ft. below the boiler-room floor line. As will be apparent from Fig. 6, the breeching proper is rectangular in cross-section and tapers both in width and in height. Owing to the necessity of locating the chimney slightly off center with the uptakes, the breeching was increased in width toward the side of the offset, thus forming a natural path for the gases from the various boilers as progress is made toward the stack. The slopes are very gradual, so that little resistance is offered to the flow of gases.

Between the uptake connections to the breeching and the last connection and the stack, expansion joints are provided. To control the course of expansion, the breeching is anchored to the concrete roof at midpoints between the expansion joints, and to afford easy travel to or from the joints, the portions of the breeching near the joints are mounted on rollers.

With the breeching outside, insulation was considered desirable to avoid excessive temperature drops. In this particular case 2-in. vitrobestos was secured to the inside of the steel plate by ¼ x 3-in. bolts staggered on 18-in. centers. The joints between sheets were pointed up, and all exposed nuts or other metal thoroughly coated and protected from the gases of combustion. Placing the insulation on the inside did not affect its heat-resisting qualities and, besides, gave the additional advantage of protecting the metal. With the inside surface of the metal protected in this way and the exterior properly painted, deterioration should be less rapid than with the usual design using unprotected plates, and the life of the breeching greatly prolonged.

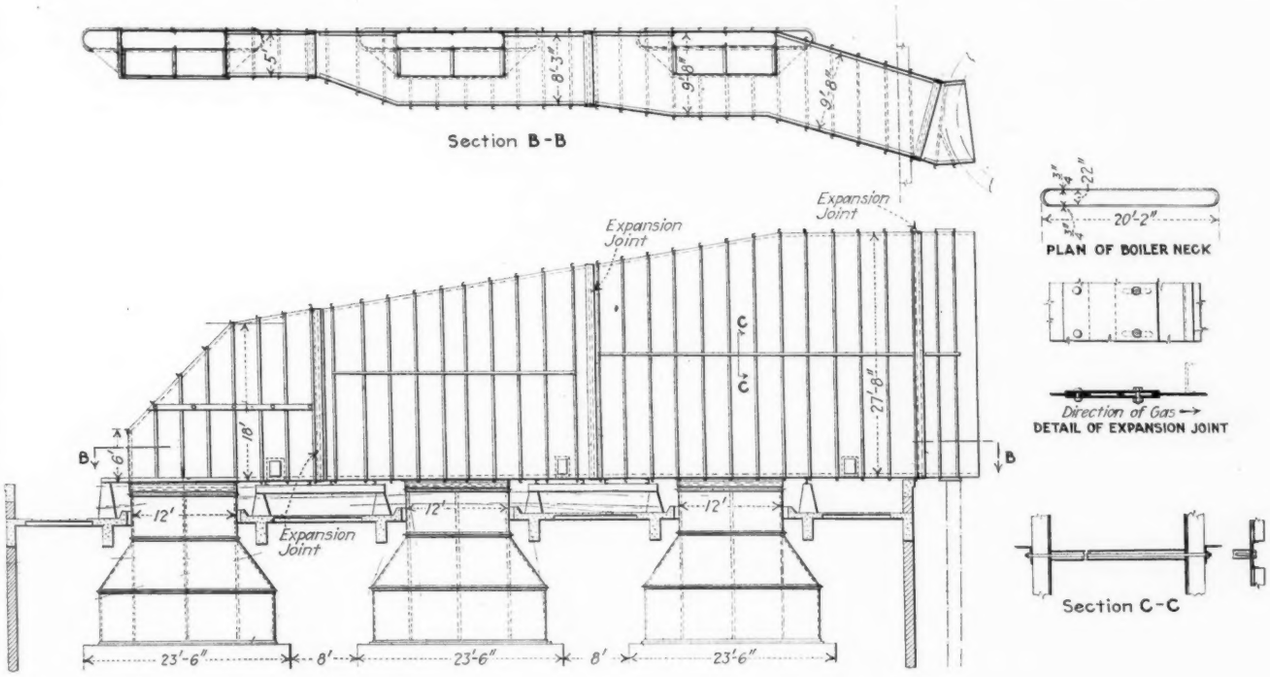


FIG. 6. STRUCTURAL DETAILS OF BREECHING MOUNTED ON ROOF OF BOILER HOUSE

One of the noticeable features in the boiler room is the lack of complicated piping. Much of it has been carried to the basement, which, with headroom of 18 ft., offered excellent facilities for suspending the piping underneath the floor slabs, the construction having been designed amply strong for the purpose. This particular type of construction afforded an easy and economical method of support. At points of anchorage proper inserts were placed in the concrete, so that the line could be rigidly secured and forced to take the expansion as designed. All piping connections are direct, and with a minimum number of bends. Few fittings have been used and turns have been made by long-radius bends, which also provide for expansion. From each boiler branches feed into a short distribution header located midway under the central firing aisle. When the future boilers are installed, it will receive steam from either side. The header now feeds over to the old plant, but

has been so valved that it may be sectionalized, and when supplying the future turbine it will be possible to operate on the unit plan.

It may be of interest to add that the high-pressure steam lines are insulated with double-asbestos-sponge-felt, 1½ in. thick, covered with canvas. The fittings are covered with ½ in. of fire-felt cement and 2½ in. of asbestos-sponge-felt cement covered with a canvas jacket. All high-pressure flanges have removable flange covers consisting of 2¾-in. asbestos-sponge-felt, lined with rolled firefelt, with covers to fit over the insulation. The exhaust piping is protected by 1-in. asbestos-cell insulation, with canvas jacket; the hot-water piping has 1 in. of asbestos-sponge-felt insulation, and all exhaust

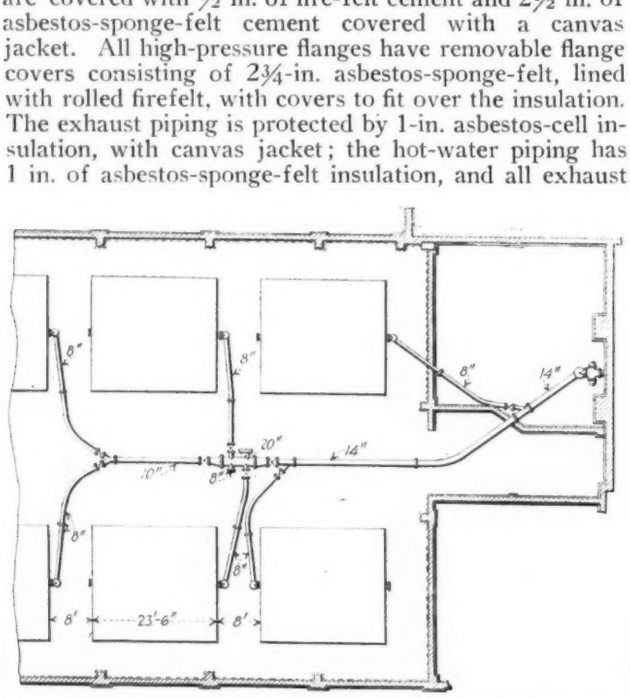


FIG. 7. HIGH-PRESSURE STEAM-PIPE LAYOUT

and hot-water fittings are insulated by a scratch coat of No. 352 cement finished with a No. 400 cement and canvas jacket. Boiler drum-heads have 2-in. magnesia blocks wired on and finished with ½-in. thickness of No. 400 cement and canvas cover.

Coal is brought to the plant in drop-bottom cars, which empty into two track hoppers 14 ft. wide by 28 ft. long. A motor-driven apron conveyor with a capacity of 70 tons per hour delivers the coal either to the crusher or direct to cross-conveyor belts, which in turn discharge onto another belt, carrying the coal to a 2-ton skip-hoist located at the end of the boiler house. The hoist is of standard passenger-elevator type, driven by a 35-hp. two-phase 440-volt motor and arranged so that the operation can be entirely automatic or controlled by hand. A skip-car travels from the loading point to the dump position, a vertical distance of about 108 ft., with full load, at a speed of 225 ft. per min. and an ultimate capacity of 80 tons per hour.

In the loading position the skip-bucket rests on a compression spring, adjustable for different loads. When the spring compresses to the desired point, a contact is made, actuating a relay which closes the cutoff valve controlling the coal feed from the hopper supplying the bucket. In closing, the valve actuates the starting relay for the hoist. The bucket is elevated to the dumping position, empties and returns to its original position, automatically opening the hopper valve to refill the bucket with coal and repeating the same cycle as before. The receiving hopper at the head of the belt conveyor is large enough to allow for small variations in the flow of coal. Another belt conveyor receives the coal from the skip-hoist and, by means of a traveling tripper, distributes it to any section of the bunker desired. All conveyors are driven from the discharge end by motors connected to spur-gear reducers which in turn are coupled to the conveyor shafts. These reducers consist of a series of gears entirely inclosed in a cast-iron housing and running in oil. With their motors the reducers are mounted on cast-iron bases with flexible couplings between motors, reducers and driven shafts. The unit is unusually small and compact, forming a pleasing contrast to the large and complicated gearing generally employed. A point worthy of mention is that all belt drives are identical, so that there is no possibility of one belt feeding to another at a rate faster than the receiving belt is able to handle.

Gates controlled from the floor admit the coal from the bunker into universal spouts, which deliver into chutes tricated at the discharge end. There are two spouts per stoker, and the six feeds give such excellent distribution of the coal that it is not necessary to do any shifting of the spouts or the coal. Owing to the difficulty of getting steel plate to make up these spouts, 10-in. pipe that had been used formerly as a heating main served the purpose. As the diameter of the pipe was considered a little small, an endless chain was passed through the chute so that it would be an easy matter to break up any clogging of coal that might take place. In case it should be desired later on to put in coal-weighing equipment, inserts have been provided for supporting the structure, and there is plenty of height to make the installation.

Under each boiler an ash hopper of sufficient capacity to care for a normal run of ten to twelve hours has been provided. To protect the concrete from excessive heat and abrasion from the ash and clinker, the interior is lined with one layer of paving brick laid in high-temperature cement. Underneath the hopper has a 24 x 36-in. discharge opening, closed by a low-body duplex cutoff valve, through which the ashes drop directly into a push-car. A loop track, taking in both rows of boilers, has been provided, and arrangements have been made so

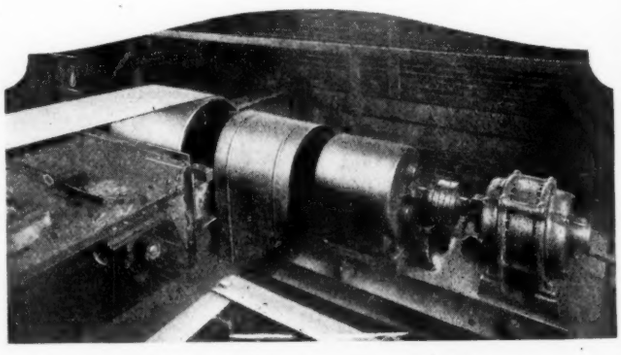


FIG. 8. MOTOR AND SMALL REDUCER DRIVING BELT CONVEYOR OVER BUNKER

that all cars, if desired, may be passed over a weighing scale. The cars dump directly into a 1-ton ash skip-hoist, which raises the ashes to the outside of the building and dumps them directly into a railway car. A grating over the inlet to the skip-bucket limits the size of the clinkers so that lumps larger than 10 in. cannot be passed through without first being broken up by a sledge.

Boiler-feed water is taken from two 7500-hp. open feed-water heaters. Underneath the heaters is a gang of centrifugal pumps provided with flexible piping connections. A loop system has been provided for the suction lines from the heaters to the pumps, so that it is easily possible to sectionalize the feed water from any individual heater to a particular pump and thus make

special arrangements when conducting boiler tests. The discharge lines also feed into a ring header giving similar flexibility. The feed-water system extends over into the old boiler plant and feeds into two loops, making in reality four feed-water lines to supply the older boilers. This was more duplication than was considered necessary for the new plant, as water conditions are fairly good and consequently a feed from either one of these loops was deemed sufficient protection against stoppage of the water supply. Under normal operation the feed to each boiler is controlled by a feed-water regulator. To insure a continuous feed to the boilers, an auxiliary loop with hand control has been provided.

Makeup water is obtained from the Mississippi River, but in case the house-service pumps should be down or the supply limited, connections have been made to draw on the high-pressure city service. Originally, the feed-water heaters were installed to give approximately a 6-ft. head on the pumps. Apparently this head was not sufficient, as the operating conditions resulting caused excessive maintenance charges. To relieve the situation, the heaters were raised to give a head of 10 ft., which was the maximum that could be obtained, owing to interference with other construction.

One of the interesting features of the boiler room is the series of runways provided to give ready access to all desired points. At the end of the boiler room steel stairways connect floor and roof. Over the center and running the full length of the firing aisle, a runway is suspended from the girders supporting the bunker. From this central location runways extend at right angles between the boilers and around to the rear, with offsets to give access to the water columns, which are mounted in front of the concrete columns rather than on the boilers, so that they will be in plain view from the firing aisle. At the rear access may be had to the feed-water regulators. Ladders lead to the tops of the boilers, where walks have been provided giving access to the safety valves and the feed-water lines. Lower down there is a second runway on a level with the check valves and the superheater clean-out doors. Another runway at the rear of the boiler is on a level with the upper clean-out doors. It will be evident that convenient and ready access were features given due consideration in the design. To insure safety to the operator, all runways are provided with railings.

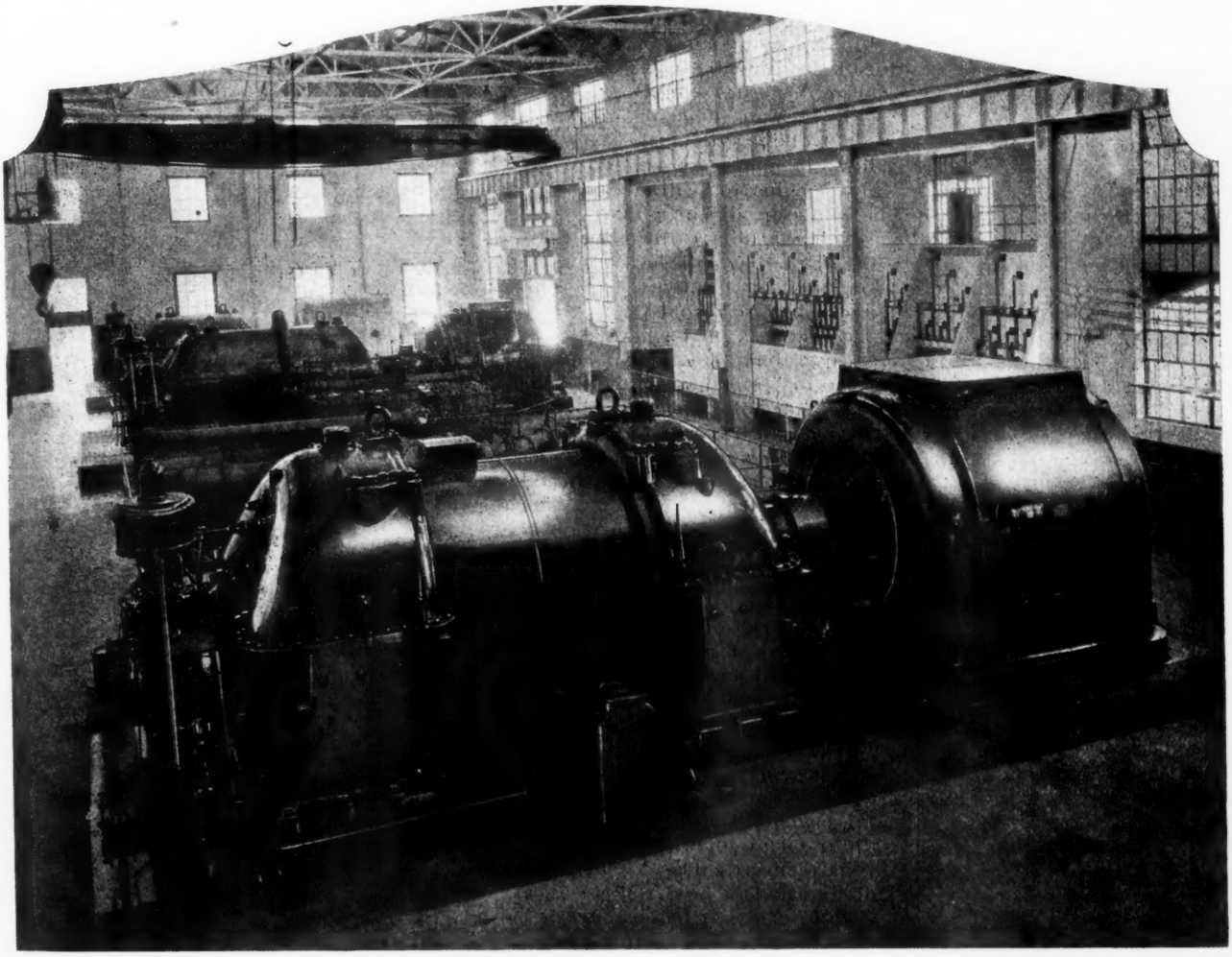


FIG. 9. TURBO-GENERATOR UNITS: THE NEW 20,000-KV.-A. MACHINE IN THE FOREGROUND

One of the essentials of a modern plant is instruments, and with these the new boiler house is amply provided. Each boiler has a panel mounted on the front of a bunker column. It contains a steam-flow meter with a recording chart and also calibrated to read directly in thousands of pounds. There is a recording thermometer for the flue gases, a CO_2 recorder and a three-in-one draft gage giving readings from the windbox, over the fire and at the uptake. Low down on the boiler front are two steam-pressure gages connected to different points of the steam drum, the idea being that one shall serve as a check on the other, or as a duplicate in case

one of the gages goes out of commission. For the same reasons there are two water columns per boiler brought out to the column fronts, as previously explained.

At the end of the firing aisle is automatic regulating equipment controlling the speed of the stoker engines, the forced-draft fan turbines, and a master damper in the breeching between the stack and the three boilers. Here also is a general instrument board containing recording steam-flow meters for each of the three principal generating units and a meter recording the steam going to the boiler-room auxiliaries. On the board there is a recording pressure gage, and an integrating meter on the steam line to the auxiliaries. With the data from these various instruments the boiler-room operator will be able to keep posted on the demands of the turbine room and separate the steam between that required for generation and that for the auxiliaries in the boiler plant. Duplicate flow instruments on individual panels in the turbine room give the operators there much the same advantage.

Changes in the Turbine Room

In the turbine room the only addition to the generating capacity is the 20,000-kv.-a. reaction turbine previously mentioned. It is supplied with steam at 200 lb. pressure and 125 deg. of superheat. The machine runs at a speed of 1800 r.p.m. and generates 4800-volt two-phase 60-cycle current. The condenser is of the surface type, containing 22,000 sq.ft. of surface, or approximately 1.4 sq.ft. per kilowatt of generator rating at 80 per cent. power factor. The auxiliaries are all of the rotary type and turbine-driven. The circulating pump has a capacity of 28,000 gal. per min., giving a ratio of approximately 70 lb. of water to 1 lb. of steam condensed. The cooling water is drawn from the Mississippi River just above the dam, and as the tailrace into which the water is discharged is ten feet lower, it is necessary to use the circulating pump only to start the flow. When it has been established, the difference in head will maintain the flow through a bypass around the pump.

A ventilating fan having a combination motor and steam-turbine drive supplies cooling air to the generator. Ducts are provided whereby the air can be supplied from the outside and returned through a separate discharge duct. In extremely cold weather, on account of the large temperature difference between the outside and inside air, undesirable operating conditions developed from condensation in the fan, forming into ice on the casing. To eliminate these difficulties, during the colder periods the cooling air is taken from the basement and discharged back into the generator room at a point some distance from the turbine. In this way the operator can control the temperature of the air that is being handled and also regulate the temperature in the turbine room, where a certain amount of heat during the winter months is desirable.

At the time of installing the air-inlet ducts, the great difficulty in securing plate steel made a change in the design to reinforced-concrete construction desirable. The walls of the duct were made of concrete 2½ in. thick and suspended from steel anchored in the concrete floor slab above. The bottom of the duct is reinforced and supported from the side walls. This type of construction made it possible to complete the work at the desired period for operation, and it has proved well adapted for the service.

Provision has been made for flooding with steam the generator ventilating system in order to quench such a fire as had developed previously in the 10,000-kw. turbo-generator. In this machine a short-circuit caused the armature to burn out, much of the damage being due to the inability of the operator to put out the fire. To guard against a similar emergency, steam connections were made into the air duct. Dampers in the inlet and the outlet were inserted to make a closed compartment possible, so that fresh air might be shut off from the machine during a fire. The main valve controlling the steam supply is sealed in a glass case to eliminate the possibility of an operator unintentionally opening the valve and admitting live steam into the generator during periods of normal operation. As a precaution against leakage of steam into the duct a second valve has been placed ahead of the main valve. In the pipe between the two valves a small hole has been bored, so that any leakage will be evident and the operator will be given the opportunity to make the necessary repairs.

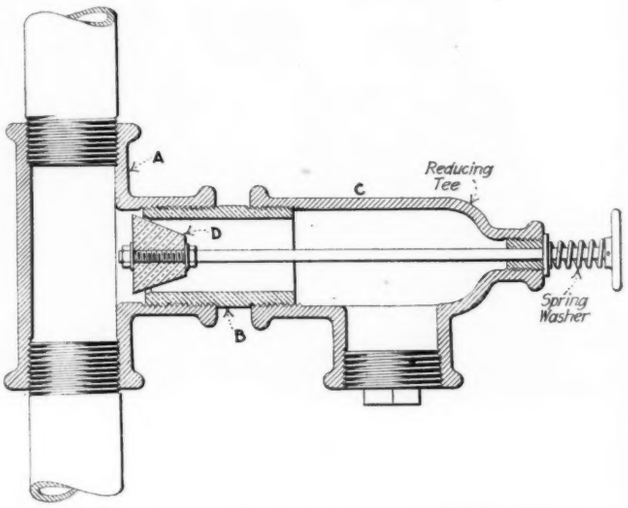
On the electrical end there is no outstanding feature, as the construction is standard and made up of good, substantial equipment. The bus is of the ring type, to which the various generators of the plant are connected through circuit-breakers. From this ring power is supplied to the Rock Island Arsenal, the City of Rock Island and to circuits going to a new transformer building, where the current is stepped up from 4800 volts, generator voltage, to 13,200 volts for distribution.

All engineering design and construction work in the new additions to the station are credited to the engineering department of the company.

Home-Made Emergency Valve

By James E. Noble

The sketch shows a home-made emergency valve that will give fair service for a considerable period when used with water at a low pressure. The tee *A* is attached to an upright water pipe; *B* is a short nipple connecting the reducing tee *C* to *A*. A cone *D* is made from hard rubber, fiber, lead or other material. A hole



HOME-MADE VALVE CONSTRUCTED FROM FITTINGS

is drilled through it to take a ⅜-in. rod, and a nut at each end of the cone holds it in place. A handle is screwed on the outer end of the rod.

To open the valve, push in on the rod handle. If there is considerable pressure in the pipe, the valve will close as soon as the handle is released. Some water may escape past the handle, but this can be prevented to some extent by placing a leather washer around the rod, holding it in place with a light spring, as shown. A strong spring will help to hold the valve shut.

The Lubrication of Steam-Engine Bearings

By W. F. OSBORNE

Beginning with a discussion of the lubrication of bearings in general, this article continues with a description of the various systems of oiling steam-engine bearings, from the primitive "squirt-can" method to the modern force-feed system and the splash type. The factors affecting the operation of lubricants in each case are discussed and recommendations made as to the proper oils to specify. The use of grease is discussed briefly.

WE ALL know that bearings are lubricated to reduce friction and wear, thereby lowering the wasted power and increasing the life of the rubbing parts. Although any substance placed between

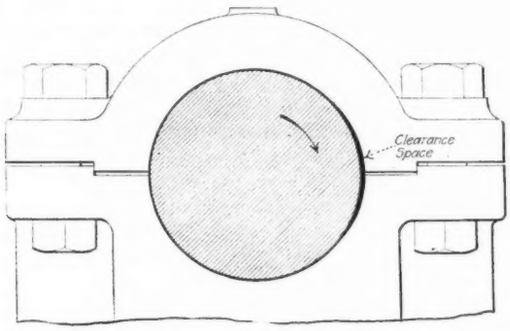


FIG. 1. WEDGE-SHAPED OPENING IN BEARING CLEARANCE

these rubbing surfaces and reducing the friction might properly be called a lubricant, we ordinarily think of lubricants as being oils or greases.

Perfect lubrication demands the complete separation of the rubbing parts, this separation depending upon the thickness of the lubrication film which must be maintained continuously. The friction of the bearing has now been changed to the sliding friction between the metal surfaces and the lubricant itself.

Efficient lubrication therefore depends upon the condition of the bearing surfaces and the body or viscosity of the lubricant. A properly designed bearing will have enough clearance between the shaft and the bearing metal to hold an oil film and will also have a wedge-shaped opening, as shown in Fig. 1, to allow the oil to feed into the clearance space. A reversing shaft should have this space on both sides. The oil is carried into the clearance by the friction between it and the shaft, and at high speeds it is carried in faster than at low speeds and the oil film can be maintained more successfully.

As has been pointed out before, the lubricant must keep the metal surfaces apart. The load on the shaft squeezes the lubricant out, the thinner-bodied oils being forced out more rapidly than the more viscous ones. It is quite practical to use thin oils when speeds are high and loads are light, but if the weight on the bearing is great enough to squeeze out the film and if the oil cannot be carried into the clearance space rapidly enough to maintain it, wear will result. Heavy oils do not squeeze out so rapidly and consequently stay in the bearing clearances longer than thin oils. On the other hand, if the shaft were running faster, sufficient thin oil might be drawn in to replace that squeezed out, thus maintaining the lubricating film.

This action might lead us to believe that heavy oils or greases were best for all bearings if it were not for other factors that must be considered. These are internal friction of the oil and the friction between the oil and the metal. Both vary with the viscosity of the oil, its quality and the character of the rubbing surfaces. Sometimes, if heavy oils are used on high-speed bearings, the friction is great enough to cause high temperatures, which can frequently be lowered by using a thinner oil. As the high temperature is a direct indication of power loss, we should make our specification read: "Use the thinnest oil that will prevent wear within a safe margin." For practical purposes oils of the same viscosity have very nearly the same coefficient of friction, although the better grades have higher lubricating values and a longer life.

Any friction existing in a bearing, however well lubricated, shows up in a rise of temperature. A hot bearing does not always mean that the metal is wearing, as the high temperature may be caused by the friction of the oil when the shaft is turning at high speeds. If the temperature rises slowly and remains below the softening point of the bearing metal, there is no need for worry; but if the rise is rapid, it is probably due to wear, and the cause should be investigated promptly and removed if possible. Bearing temperatures can be lowered by increasing the volume of the oil flowing over them.

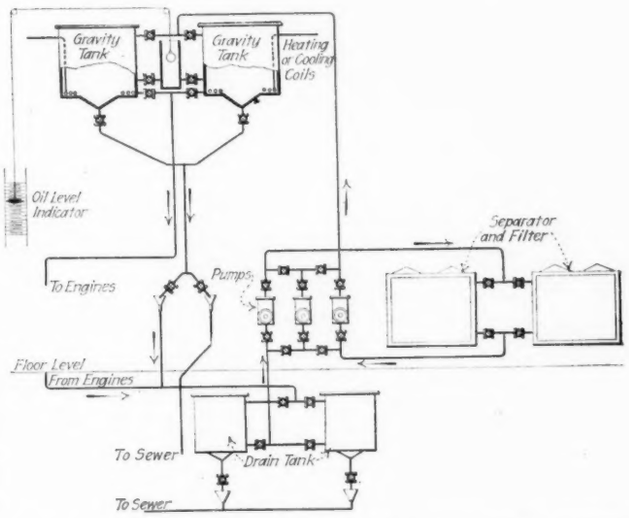


FIG. 2. GRAVITY OILING SYSTEM DESIGNED FOR STEEL-MILL ENGINES. NOTE DUPLICATE TANKS, FILTERS, ETC.

The oil absorbs the heat from the bearing and carries it away to cooler parts of the engine. It is quite possible to feed so much oil over the outside of the bearing as to carry away all the heat due to actual wear and the bearing may be wearing away without ever becoming hot to the touch. This might be caused by feeding large quantities of a thin oil to a slowly moving, heavily loaded bearing with large clearances. The large clearances would lead the oil away to the ends of the bearings, thus cooling the shaft without very much of the oil ever getting in between the wearing surfaces.

There are so many factors which affect the lubrication of a bearing—loads per square inch, rubbing speeds, radiated heat, clearances, character of surfaces, kind of bearing metal, variation of speed or load, quantity and frequency of oil supply, etc.—that it is rather difficult sometimes to select the most efficient lubricant without actual test. If we could always be sure of all the conditions, we could make very definite recommendations, but until we can determine them, we must necessarily allow a pretty large margin of safety.

The parts to be lubricated on steam engines are the

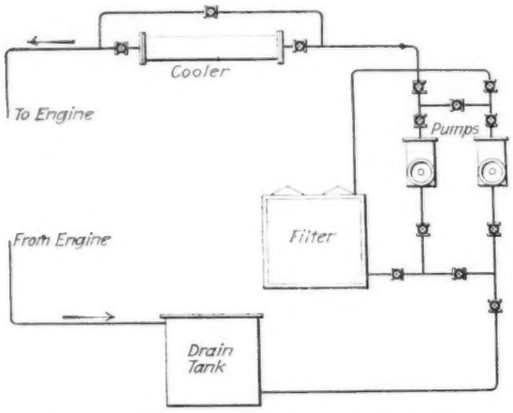


FIG. 3. FORCE FEED OILING SYSTEM

main journals, crankpins, connecting-rod pins, crossheads and guides, eccentric straps, valve gear, governor, cylinders and valves. It is customary to use the same kind of lubricant on all of these parts with the exception of the cylinder and valves, the grade depending chiefly upon the operating conditions of the engine and the oiling methods and appliances.

The most primitive way of lubricating an engine is to squirt a little oil from a squirt can into a hole in the bearing cup and let the oil run down to the surfaces. If the oil does not last until the oiler gets around again the bearings will run dry and wear. Lightly loaded engines sometimes use thin oil, but heavier oils are always more economical and are more likely to stay in the bearings until the parts are oiled again. Only small engines of the older types are now lubricated in this way, although minor bearings of small machinery are sometimes oiled by this method. Medium- or heavy-bodied oils of from 250 sec. to 500 sec. viscosity at 100 deg. F. are best suited for this service.

An improvement in lubrication was made when the oil cup with its drip feed was introduced. This method maintains a fairly regular supply of oil, requires less attention from the oiler and has been used for a great variety of operating conditions. Medium-bodied oils of between 175 sec. and 300 sec. viscosity at 100 deg. F. are usually selected for engine bearings lubricated in this manner. If the oil is used only once and is permitted to go to waste, the less expensive grades of oils are good enough, but if the oil is caught in pans, filtered and used over again, it pays to buy the better grades.

The manifold, with its reservoir and various leads to different bearings, is merely an extension of the drip-cup idea with the thought of cutting down labor and attention on the part of the oiler.

The ring and chain oilers were introduced to provide a continuous flood of oil to the bearing surfaces and to reduce the cost of lubrication by automatically returning the oil to the bearing. The flood of oil carried up by the ring or chain thoroughly lubricates the surfaces, washes out the dirt and minute bits of worn metal, and carries away part of the generated heat, thus cooling the bearing. The oil reservoir below the bearing should hold enough oil so that the dirt will have time to settle out to the bottom, and to permit the radiation of the absorbed heat. Light- or medium-bodied oils of from 150 sec. to 200 sec. viscosity at 100 deg. F., depending upon the loads, speeds, etc., will handle this sort of work all right. The better grades of oils are more economical, as they last longer, do not evaporate so quickly and maintain their original viscosity longer than the cheaper oils. This evaporation increases the viscosity of the remaining oil and causes the foreign matter to settle out more slowly.

An extension of the ring-oiler idea is the continuous circulating system with which most modern engines are now equipped. There are four types, commonly called gravity feed, forced feed, splash feed and automatic feed. The first one, shown in Fig. 2, consists of an overhead tank, commonly called a "gravity" tank, holding a supply of oil. Oil pipes lead the oil from this tank to the various parts requiring lubrication to which it is fed continuously in rapid drops or in a fine stream. The quantity needed for any bearing surface can be regulated very easily, and all parts may be flooded with oil if desired, washing out foreign matter and cooling the bearing by carrying away the generated heat. The oil flowing from the bearings is collected in troughs, pans or the engine bed and drained to a catch tank located below the engine. Sometimes a portion of the engine bed is arranged to serve for this purpose. From the catch

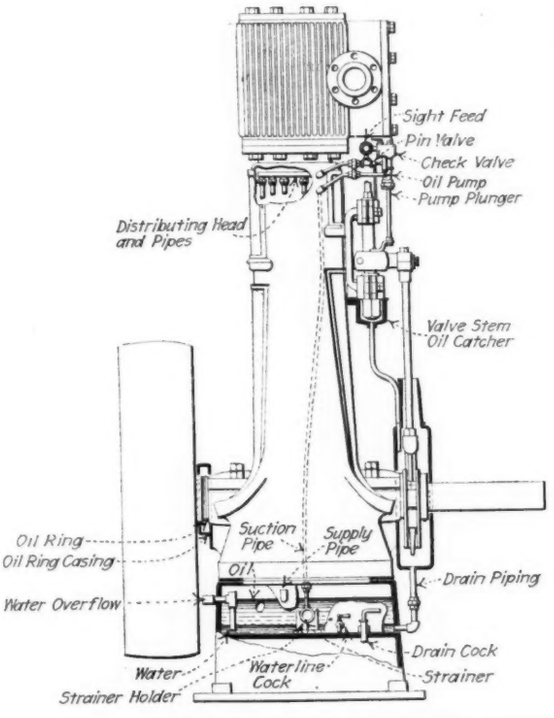


FIG. 4. AUTOMATICALLY LUBRICATED ENGINE

tank the oil is pumped back to the gravity tank to be used again, having first been cleaned by passing through filters.

The force-feed system shown in Fig. 3 does not always have the gravity tank, and the oil is forced directly from the oil pump to the bearings under a pressure of from two to ten pounds. The gravity tank is always a good thing to have in starting the engine unless a separate steam pump is installed to be operated independently of the engine. The force-feed system has the advantage that the flow of oil through any bearing can be increased by raising the pressure. In the gravity

system shown in Fig. 2 the flow of oil over the outside of the bearing can be increased greatly, but the amount of oil actually passing between the surfaces depends on the bearing clearances and the body of the oil, as the pressure forcing the oil through is fixed by the height of the gravity tank above the engine. It is customary also to install a sight-feed oiler just above the bearing, which absorbs the pressure due to the height of the gravity tank and reduces the pressure head on the bearings to a few inches.

In both of these systems the oil from the bearings carries small particles worn from the bearing metals, bits of dirt and foreign matter settling on the engine, condensation water leaking through the piston-rod and valve-rod stuffing-boxes and saponified cylinder oils carried in by the condensation water. If these foreign elements were allowed to accumulate, they would soon contaminate the oil to such an extent that it would no longer be of any value as a lubricant. Both systems should be equipped with settling tanks or separators for removing the water and heavy foreign matter, and filters to remove the lighter particles which will not settle out when the oil is at rest.

We now have something else to consider besides viscosity, and that is the ability of the oil to separate from water and foreign matter. As mentioned in the first article of this series, the quality of the oil, its viscosity and its specific gravity affect its separation from water. Of these the most important is quality, which can be regulated initially only by the refiner. The viscosity, which is second in importance, can be changed by heating the oil in the system until it becomes thin, thus permitting the water and dirt to settle out more readily. Heaters are placed in the separators, and the oil is heated to 110 to 125 deg. F., depending on its viscosity. The circulating system, by providing a flood of oil to all parts, permits the use of light-bodied lubricants which separate from water quickly and can be cleaned very satisfactorily by an efficient filtering system.

The quality of the oil that should be used depends to a certain extent on the efficiency of the system as a whole. If the system is tight and there is very little loss through leakage or by splashing, a high-grade oil can and should be used. In such a system very little new oil is added to make up for loss and the old oil remaining in the system should have all the qualities necessary for efficient cleaning. Again, the continuous evaporation of the oil when passing over the bearings drives off the lighter portions and the viscosity of the remaining oil gradually increases. On this account it is advisable to start out with a fairly light-bodied oil, even though the intitial evaporation may be greater, because the viscosity of the oil in the system can be maintained better by the addition of a light-bodied oil than by a medium oil.

If the system is constructed so that it loses considerable oil through leaky pipes, splashing from the engine as is the case with vertical engines, burning up of the oil splashed against hot cylinder heads, and other numerous causes, the quantity of the makeup oil is much greater, the oil does not remain in use so long and its viscosity does not increase as rapidly. Consequently, less expensive oils may be used if desired.

Splash Systems of Lubrication

Splash systems supply a flood of oil to all parts when the engine is running, but have the disadvantage that they must depend upon enough oil remaining in the bearings to lubricate them when first starting the engine. A splash-lubricated engine should be tightly inclosed—not only to prevent loss of oil, but to keep out moisture and dirt. In such systems the oil is constantly churned up and has very little opportunity to come to rest and permit the water or foreign matter to settle out. Consequently, a very high grade of oil should always be used, one that will separate from water quickly and one having a minimum evaporation during use. Excessive evaporation from an improperly refined oil will cause the viscosity to increase rapidly and the oil will not clean itself as it should. When the oil becomes loaded with foreign matter up to a certain point, it will emulsify or form a thick, heavy mass, which will clog up the oil pipes and grooves and prevent any oil getting to the working surfaces.

The automatically lubricated engine shown in Fig. 4 has a pump to take the oil out of the crank case and deliver it to the bearings. After lubricating them, the oil returns to the crank case for further use. The presence of water and the rapid agitation necessitate the use of a high-grade oil like that recommended for the splash method.

Some General Recommendations

In picking out oils for each of these systems we must consider all the individual operating conditions carefully and the effect they will have upon the oil to be selected. It is possible, however, to make general recommendations as follows:

Splash and Automatic Systems—Use as light an oil as will lubricate the bearings. Viscosities 150-180 sec. at 100 deg. F. Highest quality obtainable and with best separating qualities as shown by emulsification tests.

Force Feed or Gravity Systems—Use light- or medium-bodied oils. Viscosities 150-200 sec at 100 deg. F. Light-bodied, high-quality oils are best for efficient systems, medium-bodied good-grade oils are suitable for less efficient systems.

Ring or Chain Oiled Bearings—Use medium-bodied oils of good quality. Viscosities 150-200 sec. at 100 deg. F., depending upon bearing loads and speeds.

Drip Cups and Manifolds—Use medium-bodied oils of 175-250 sec. at 100 deg. F. Unnecessary to use more expensive grades.

Squirt Can—Use medium- or heavy-bodied oil. Viscosities 250-500 sec. at 100 deg. F. Ordinary red engine oils are satisfactory.

A low cold test is desirable where the engine is exposed to low temperatures.

Some engineers prefer to have certain bearings lubricated with grease, which is not to be recommended as the best method of reducing friction to a minimum, although it does cut down the labor of caring for engines on which the expense of installing a circulating system is not warranted. The valve gear of many engines is equipped with compression grease cups which are easier to turn down when the engine is running than it is to try to lubricate the bearings with a squirt can without splashing oil all over the place. Whenever used, the grease should be of a good quality, homogeneous and free from any nonlubricating material which might separate and plug up the grooves.

Snow is the latest agency to be employed by officials in solving Salt Lake's smoke problem, according to H. W. Clark, Bureau of Mines, who is assisting in the smoke probe. Particles of dust in circulation are precipitated with snow, and consequently, the atmosphere is freed from impurities. Samples of snow have been taken by the Bureau of Mines and are now being analyzed. These results will be used to check the data acquired through the use of special apparatus for testing the atmosphere impurities, says Mr. Clark. The snow-testing method is based upon filtering melted snow from certain areas, the solid material containing acids, ammonia, sulphates and other impurities, being weighed and subjected to microscopic examination.

Standard Meter Rates—How Applied in Calculating Power Bills

By LeROY W. ALLISON

The previous article concluded with an explanation of the classification for "meter rates" and "demand rates" as now in common use. The first group, meter rates, is considered in the following, and includes (1) *straight-line meter rate,* (2) *step meter rate and* (3) *block meter rate.*

THERE are three general classes of central-station service—general service, regular power service, and large light and power service. The standard rate forms cover these different phases of operation in a manner that approximates equity to company and consumer. When it comes to a matter of actual contract for certain service, modifications may be made as required, say for temporary service in part, particular line extensions, and so on, but these changes or provisions have little, if anything, to do with the basic type of rate calculation.

Rate Definitions

A familiarity with the exact meaning of the different rate terms in current use is quite essential for an accurate understanding of the schedules. These, as noted in the text of this series of articles, are the definitions as approved by the Rate Research Committee of the National Electric Light Association, to the papers of which organization the writer is indebted for considerable information. The term "meter rate" is applicable to any method of charge for electric service which

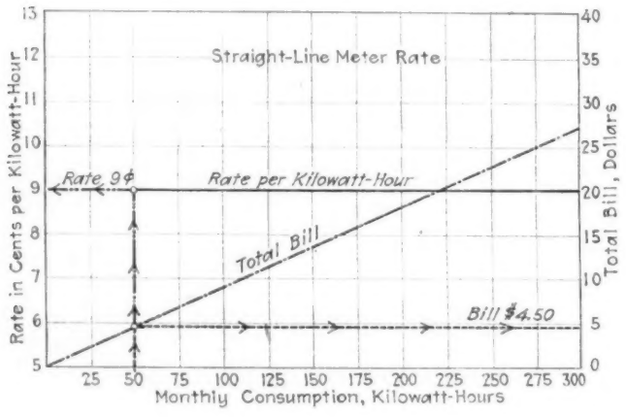


FIG. 1. GRAPHICAL REPRESENTATION OF A STRAIGHT-LINE METER RATE

is based on the amount used. This amount is expressed in units, as kilowatt-hours of electricity. Integrating meters or graphic meters are used.

Straight-Line Meter Rate

The term "straight-line," as used in connection with, and as applied to any method of charge, indicates that the price charged per unit is constant; that is, does not vary on account of any increase or decrease in the number of units used. The total sum to be charged is obtained by multiplying the total number of units by the price per unit.

The straight-line meter rate is extremely simple and is one of the standard forms in wide general use by central stations, particularly in the matter of commercial-lighting service. This type of rate schedule was adopted coincidently with metered method of measuring electric service, first under ampere-hour meters, and later, under watt-hour meters. The charge under

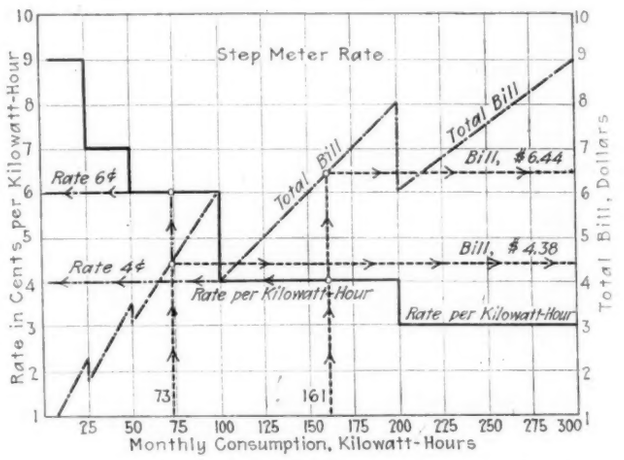


FIG. 2. GRAPHICAL REPRESENTATION OF A STEP-METER RATE

this type of metered service is made at a fixed rate per ampere-hour or watt-hour. Fig. 1 represents this meter rate graphically and shows at a glance the simplicity of this form of computation. As an example, assume a rate of 9 cents per kilowatt-hour and a total monthly service aggregating 50 kw.-hr., the charge would be $50 \times 9 = \$4.50$, as indicated on Fig 1.

Step Meter Rate

The term "step," as used in connection with and as applied to any method of charge, indicates that a certain specified price per unit is charged for all or any part of a specified number of units, with reductions in the price per unit based upon increases in the number of units according to a given schedule. The total sum to be charged is obtained by multiplying the total number of units by the price applying for this number of units, or, in other words, by the primary price, and then deducting the discount applying for this number of units.

In further explanation of this standard definition the unit rate as charged depends on the particular "step" within which the total consumption comes. The term "step" typifies the character of the plotted rate, in its resemblance to a flight of steps, as will be noticed in Fig. 2. This diagram has been plotted for a step meter rate varying from 9c. to 3c. per kw-hr. on the following basis: For electric-energy consumption from 1 to 25 kw.-hr. per month, 9c.; from 26 to 50 kw.-hr., 7c.; from 51 to 100 kw.-hr., 6c.; from 101 to 200 kw.-hr., 4c.; and all over 200 kw.-hr. consumption in a month, 3c. Under this schedule the average rate per kilowatt-hour is 4½c.

and as will be seen, the rate decreases as the consumption increases.

The figuring of the total charge under this rate system is a very simple matter. Assume that a customer has used a total of 73 kw.-hr. during the month; this would fall within the 6-cent step rate, and the total charge would be 73 × 6, or $4.38. Or, again, assume that a total of 161 kw.-hr. has been used during the month; the rate would be within the 4-cent step, with

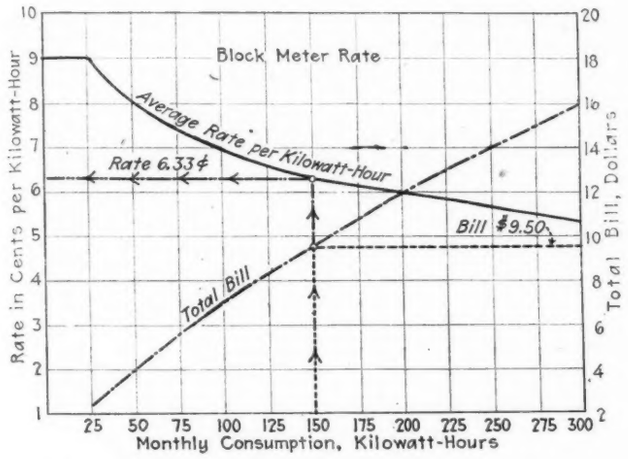

Block Meter Rate
Average Rate per Kilowatt-Hour
Rate 6.33¢
Bill $9.50
Total Bill
Rate in Cents per Kilowatt-Hour
Total Bill, Dollars
Monthly Consumption, Kilowatt-Hours
25 50 75 100 125 150 175 200 225 250 275 300

FIG. 3. GRAPHICAL REPRESENTATION OF A BLOCK-METER RATE

total charge, 161 × 4, or $6.44. The dotted lines, Fig. 2, show how the bills may be read from the curves. Owing to its simplicity, this method of rate computation is in wide general use both for wholesale and retail power service, as well as for general and commercial lighting work.

Block Meter Rate

The term "block," as used in connection with and as applied to any method of charge, indicates that a certain specified price per unit is charged for all or any part of a block of such units, and reduced prices per unit are charged for all or any part of succeeding blocks of the same or a different number of such units, each such reduced price per unit applying only to a particular block or portion thereof. The total sum to be charged is obtained by multiplying the number of units in the first block by the price per unit for that block and adding thereto the number of units in the second block times the price per unit for that block, and so on until the sum of the units falling within the different blocks equals the number of units to be charged for.

Under the block-meter rate system, certain blocks are arranged covering a specified number of kilowatt-hours in each block, as 25, 50 or 100 kw.-hr. or as the case may be. This type of rate computation is extremely simple, readily understood by consumers and allows for rapid calculation of bills in the clerical department of the central station. It has been adopted by many companies for general lighting, wholesale lighting and power, as well as for retail power and other character of service. This method of figuring charges corresponds in a general way to rates of the demand type.

This rate basis is shown diagrammatically in Fig. 3, the two curves covering the average rate per kilowatt-hour and the total bill being plotted for the specific conditions as apply. In this instance, the rate varies from 9 to 4 cents for the different blocks, as follows: For the first 25 kw.-hr. used per month, 9c.; for the next 25 kw-hr., 7c.; for the next 50 kw.-hr., 6c.; for the next 100 kw.-hr., 5c.; and for excess of all over 200 kw.-hr. used per month, 4 cents per kilowatt-hour. As an idea of the method of computing bills, say that a consumer uses a total of 150 kw.-hr. under this system of charges, in a monthly period. The first 25 kw.-hr. would be figured at 9c., the next 25 at 7c., the next 50 at 6c.; and the last 50 at 5 cents, or

25 x 9 = $2.25
25 x 7 = 1.75
50 x 6 = 3.00
50 x 5 = 2.50

Total bill $9.50 for 150 kw.-hr.

The average rate is equal to the total bill, in cents, divided by the total kilowatt-hours or, in this problem, equals 950 ÷ 150 = 6.33c. per kw.-hr. These values are indicated in Fig. 3 by the dotted lines.

The block-rate system is on a basis of metered service. The difference between this operating schedule and the step-meter rate plan, previously explained, will be readily noted from the examples given. Under the step-meter schedule, the rate at the particular step of consumption applies to the gross sum of the kilowatt-hours used, while with the block-meter rate, each block, or division of consumption rate charge, is computed on the unit basis as arranged for the block.

Power Service Under Block Meter Rate

An exact illustration of the use of the block meter rate system by a large Eastern central station will be interesting, this covering the application to the state utility commissioners for an increase in the existing uniform retail power rate, for which the block meter schedule is employed by the company. In the application and hearing, the data on this point as set forth were as follows:

Blocks	Uniform Retail Power Rate	Present Rate	Proposed Rate
First Block	10 cents to be paid per kilowatt-hour of consumption each month up to and including an amount of kilowatt-hours per horsepower of maximum demand of	20 kw.-hr.	30 kw.-hr.
Second Block	To be paid per kilowatt-hour for the next 50 kw.-hr. consumed in such month in excess of the first step of the rates	6 cents	8 cents
Third Block	To be paid per kilowatt-hour for the next 500 kw.-hr. consumed in such month in excess of the first and second steps of the rates	4 cents	5½ cents
Fourth Block	To be paid per kilowatt-hour for the consumption in such month in excess of the consumption mentioned in the first, second and third steps of the rates	2 cents	2.7 cents
	The customer to agree to a minimum bill each month equal to an amount per horsepower of the full rated capacity of the connected load amounting to	50 cents	70 cents

Power Service Under Step Meter Rate

This central station in connection with wholesale power distribution, uses the step-meter rate system for a phase of its uniform wholesale power service. In the schedule filed with the utility board for a proposed increase in such charges as in force, the different step classifications are made in the following manner:

Uniform Wholesale-Power Rate	Present Rate, Cents	Proposed Rate, Cents
A charge for electric power consumed to be paid each month as follows:		
For each kilowatt-hour of consumption in such month up to and including 3000 kw.-hr.	3 cents	4 cents
For each kilowatt-hour of consumption in such month over 3000 kw.-hr. up to and including 10,000 kw.-hr.	2 cents	2.7 cents
For each kilowatt-hour for excess consumption in such month over 10,000 kw.-hr.	1 cent	1.35 cents
The customer to guarantee a minimum monthly bill of	$300	$400

(The subject of "demand rates" will be discussed in detail in the next and last article on "Standard Meter Rates.")

Refrigeration Study Course—III. The Ammonia Compressor

By H. J. MACINTIRE

Professor Mechanical Engineering, University of Utah

IN THE preceding article it was shown that a refrigerating cycle was much like a steam-engine cycle, only that it was a cycle with the events in the opposite order. Also, it was shown that the refrigerating coils acted similarly to a steam boiler, but that the capacity of the coils depended on local conditions of operation. The compressor is the only part of the machine requiring an input of power. Whereas

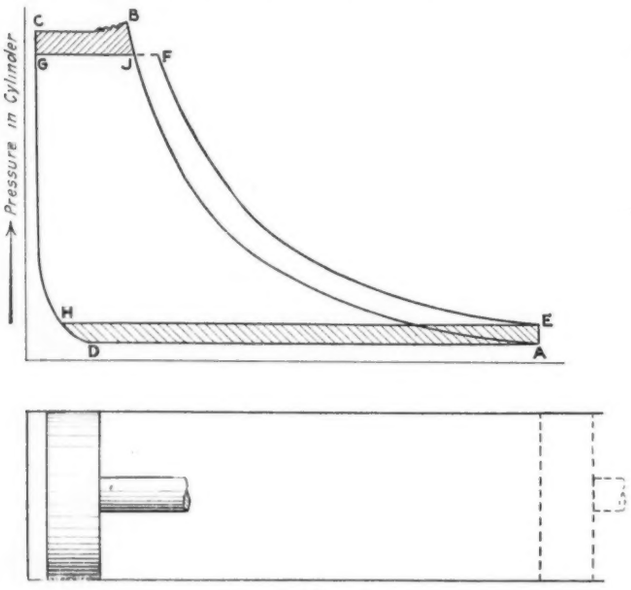


FIG. 1. INDICATOR DIAGRAM FROM AMMONIA COMPRESSOR

inefficient condensers or refrigerating piping might prevent obtaining capacity, yet the compressor alone is the place where economy of operation may be looked for.

Comparison with the Air Compressor

The problem of compressing ammonia is so like that of compressing air that the same machine may be used for either substance except for details to secure tightness. This is especially difficult with ammonia because of its ability to pass through material and joints that would be tight for compressed air. Another difference in the design is the absence of mechanically operated valves for refrigeration. These have never been applied to ammonia with success because designers do not care to increase the number of possible leaks, as would be necessary if mechanically operated valves were installed with the necessary stuffing-boxes into the cylinder. One other difference is to be found in that single-stage compression is used except in isolated cases —although one may venture to say that two-stage compression will be used more in the future. The use of the single stage is surprising when one remembers that in air compression multistage generally is employed if the discharge pressure is 70 lb. or more. To understand the problem of compressing ammonia a study of the valve action will be made, as shown in the indicator diagram, Fig. 1.

The reader will remember that the indicator diagram is simply an indication of the pressure in the cylinder for each and every portion of the piston. By means of special apparatus we are able to record to a special (known) scale the pressure inside the cylinder during the entire cycle of suction, compression and discharge of the gas. If the entrance into the cylinder is constricted, then the gas will have difficulty in getting in and the result is a partial vacuum formed during the suction stroke. If the discharge passages are constricted, there will be difficulty in getting the gas out of the cylinder promptly, and in forcing it out the piston has to increase the discharge pressure. Let us see how these points are represented on the diagram, remembering that every square inch of area on the indicator diagram represents a certain number of foot-pounds of work done on the gas by the piston, and so by the engine or electric motor driving the piston.

Effect of Valves and Ports

There are two separate indicator diagrams shown in Fig. 1. First we will discuss the one shown by the letters *ABCD*. This diagram represents the effect of suction and discharge valves and passages that are too small for the size and speed of the piston. The ammonia gas begins to enter the cylinder at the point *D* and continues to the end of the stroke represented by

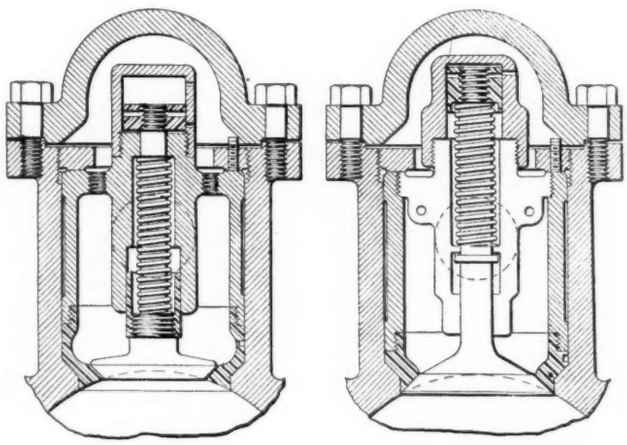


FIG. 2. THE TYPE OF POPPET VALVE SO SUCCESSFULLY USED ON SLOW-SPEED COMPRESSOR

the point *A*. On the return stroke the suction valve closes and the entrapped gas is compressed along the line *A B* until the discharge pressure *B* is reached, when the discharge valve opens and the compressed gas leaves the cylinder into the discharge pipe and the condenser. As the piston begins to move toward the right, the gas in the clearance volume expands until a pressure equal to the ammonia pressure in the suction bends is reached or some lower pressure, depending on conditions that prevail. This point is shown by *D* when the suction valve again opens for passage of a new volume of suction ammonia.

Now, if the suction gas could have entered freely into

the cylinder, the pressure would have been higher and the suction line would have been *HE*. Also, if the discharge out of the cylinder could have been free, the exit would have been shown by *FG*. In each case the cross-hatched area *DAEH* and *JBCG* is unnecessary work, but has to be supplied to get the gas into and out of the cylinder. In addition (as the suction pressure was less) the weight of ammonia pumped per revolution is much less, as shown partly by the length of the lines *GF*, *GJ*. It will be seen, if a study is made of ammonia-compressor design, that the main differences in each design (other than in safety of operation) are in an attempt to provide as free and unrestricted passage into and out of the cylinder as is possible for the type of construction that is used.

The Suction and Discharge Valve

By far the most successful type of valves used in refrigeration has been the so-called poppet valve shown in Fig. 2. Both suction and discharge valves have devices to prevent more than a predetermined travel. This point is especially important for the suction valve which might otherwise be caught in the cylinder, thereby causing a fracture of the cylinder and a release of the ammonia charge. Another feature is some dashpot arrangement generally used to prevent pounding. This is accomplished, usually, by means of a dashpot device—shown in the figure—which prevents seating of the valves with a shock. The poppet type of valve is reasonably safe, remains tight for a long period and is readily reground. There is always a helical spring provided to assist in quick closing. The suction valve is slightly different in the vertical single-acting compressor.

In the vertical single-acting compressor the return gas enters the crank case or the space between the top and bottom parts of the trunk piston as shown in Fig. 3. The valve is placed in the upper face of the piston and is usually so adjusted that its weight is just balanced by the spring and is then sensitive to any difference of pressure on the two sides of the piston. On the down stroke the valve opens and allows the return gas to pass through into the upper part of the cylinder. The valve itself is of the poppet type, and is popular, especially in the small-size compressors—say up to twenty tons of refrigeration.

Recently, the demand for high-speed machines, in order to secure greater capacity of direct connection to synchronous motors (in the larger sizes of refrigerating machines) or reciprocating engines of moderate speed, has promoted the development of a special form of valve of slight inertia and of large valve opening. These valves are known as plate valves or feather or ribbon valves. The feature of the high-speed valve is small inertia (usually of thin, special steel, ground to the seat) and they are flexibly held on their seats by light springs.

Safety Heads for Emergency Use

For some time it has been considered that clearance in ammonia compressors must be kept down to a minimum, and therefore special safety provisions must be made to prevent accident should liquid ammonia or a broken valve get into the cylinder. By clearance is understood both the striking clearance, which is frequently $\frac{1}{32}$ in., and volumetric clearance, which includes all the volume of entrapped vapor at dead-center. This latter is usually less than ½ per cent. of the total piston displacement. The dire results of moderate amounts of clearance as affecting economy of operation have been exploded for a long time, but the small-clearance machines still retain their popularity, particularly in the twin vertical single-acting compressors. The twin vertical machines, which are usually designed for moderate and sometimes for high speeds, lend themselves best to the construction of a safety head. This is simply a false head, shown in Fig. 3, held by stiff springs and designed for use only in cases of emergency. Should a slug of ammonia come over—like water in a steam engine—the entire head is expected to lift quickly enough to relieve the pressure, similar to the relief valves on a Corliss engine. At present no provision is made to apply the principle to the horizontal machine, which almost invariably is of a double-acting design.

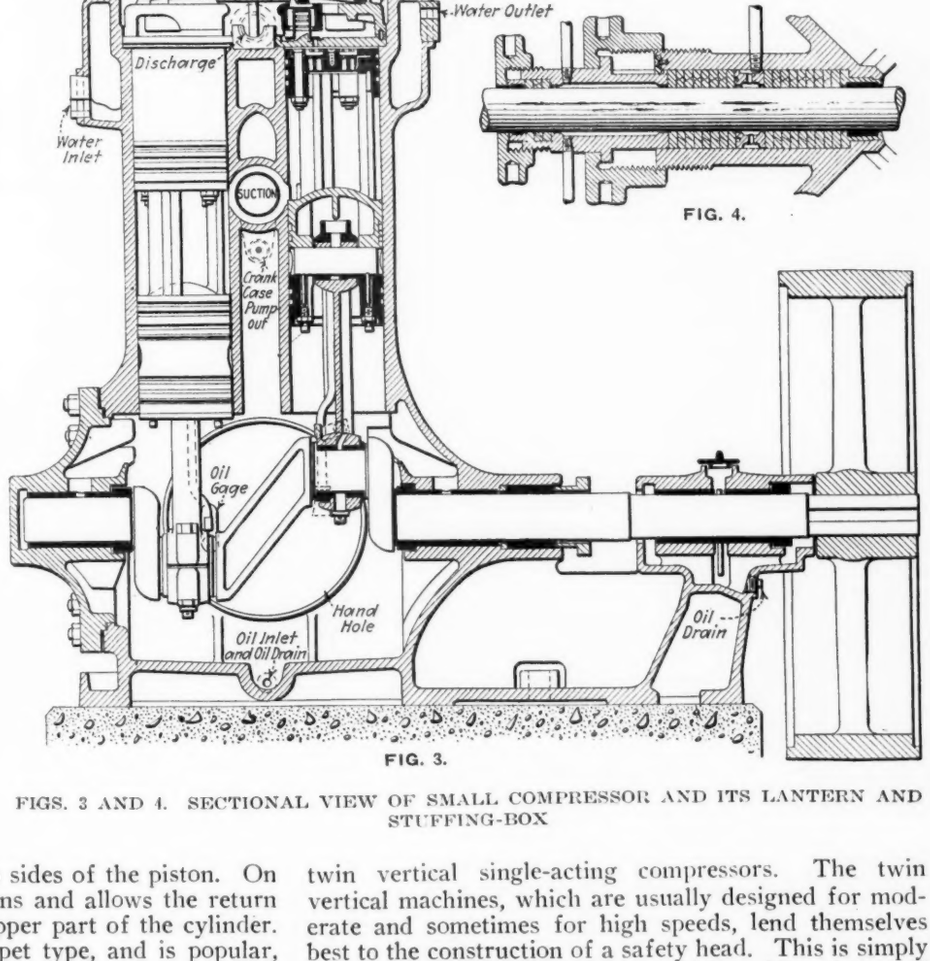


FIG. 4.

FIG. 3.

FIGS. 3 AND 4. SECTIONAL VIEW OF SMALL COMPRESSOR AND ITS LANTERN AND STUFFING-BOX

For some time it has been generally conceded that operating engineers have been much too liberal with oil, the result being that this oil passed over to the condenser and finally to the refrigerating coils. Oil in the condenser pipe or evaporating coils is almost as bad as oil in boiler tubes—certainly as bad so far as transmission of heat is concerned. The result has been that many engineers have advocated little or no oil feed into the standard horizontal machine, believing that enough would carry over from the stuffing-box. The vertical machines of the inclosed type are "splash" lubricated, and the main difficulty with this form of design is to prevent the oil from passing out through the discharge and leaving the crank case with improper oil supply. The higher the speed the greater this difficulty.

Stuffing-Box Packing

For a machine properly erected, metallic packing is far the best. With soft packing the friction is much greater. The double-acting machine is usually constructed with a "lantern," as shown in the figure. On the bottom of the lantern is a connection to the oil supply, and the upper is connected to the suction heads. The result of this design is to prevent a greater pressure than the suction on the last part of the stuffing-box.

The Frame and the Bearings

In ammonia compression the forces developed are severe and alter so as to give repeated stress. The result is that the material entering into the construction must be of high quality and liberal in weight. The cylinders should be capable of several reborings. The bearings must not only be designed for low bearing pressures per unit of projected area, but should be capable of adjustment. We are now agreed on the policy of using a water jacket to prevent excessive temperatures in the discharge gas, but the tendency is to put them in the cylinder head only or the last portion of the cylinder barrel.

The manner of taking up the heat developed during compression was at one time a matter of bitter controversy, but engineers are now fairly well agreed on the subject. Some years ago it was the usual custom to bring back wet gas to the cylinder (ammonia with a certain percentage of liquid, similar to wet steam), and this liquid was expected to vaporize during compression and prevent undue rise of temperature. Provision was made to bleed liquid ammonia in the suction header so as to secure better adjustment of conditions. The other method was to provide a water jacket around the entire cylinder barrel and to hope that the jacket water would prevent excessive discharge temperatures, as well as achieve high efficiency of compression. We know now that water-jacketing in parts of the cylinder barrel does more harm than good, and that only in single-acting machines, where the jacket is placed near to the end of the cylinder (the third last), is it of appreciable value. In fact, the cylinder head is the only place where much advantage can be derived.

The reasons for the foregoing statements can be seen by studying what takes place. At the beginning of compression the gas has a temperature around zero degrees F., and it is not until after midstroke that a temperature above that of the cooling water is obtained. The end of the stroke is where the high temperature is obtained, and that is where the water jacket can make itself useful. In wet compression (where liquid injection is used for cooling) proper control cannot be maintained. The result is that we consider now that best efficiency is obtained by bringing back dry and saturated gas to the cylinder and using a water jacket where it will be of value.

One of the most serious considerations that refrigerating engineers have to remember is the volumetric efficiency of the compressor. Not only must one remember about the volume of a unit weight of ammonia and how this increases greatly as the suction pressure is decreased, but that the gas caught in the clearance space will expand and cause a piston to move 18 to 50 per cent. or even more before a new supply of ammonia is drawn into the cylinder. In addition, it is possible that the ammonia at the end of the suction stroke is superheated (like superheated steam) and therefore occupies a greater volume than it should. For instance, the volume of one pound of dry and saturated ammonia at 20 lb. gage pressure is 8.01 cu.ft.; but if the gas returns at the same suction pressure at 30 deg. F., then the volume will be 8.6 cu.ft., or an increase of 7½ per cent. Therefore, as useful refrigeration is proportioned to the weight of ammonia pumped, then the piston displacement will have to be increased a like amount or the capacity will be reduced. This shows the importance of bringing back the ammonia to the machine without superheat. Some engineers consider that the hot metal in the cylinder heats the gas during the suction stroke, but on account of the low temperatures encountered in refrigeration, the low coefficient of conductivity of the metal because it is dry, and the short time allowed to heat in, the amount of this superheating is very small. Leaky valves and piston rings are much more liable to cause trouble. The following table of volumetric efficiencies with no clearance and with 4 to 6 per cent. clearance, and the horsepower per ton of refrigeration, will be of interest:

HORSEPOWER PER TON OF REFRIGERATION

Condenser Pressure Lb. Gage	Suction Pressure Lb. Gage 5	10	15	20	25	30
145	2.02	1.69	1.40	1.26	1.11	0.99
155	2.11	1.76	1.48	1.38	1.19	1.05
165	2.21	1.85	1.57	1.41	1.25	1.13
175	2.34	1.94	1.65	1.482	1.34	1.18
185	2.48	2.03	1.75	1.57	1.40	1.27
195	2.55	2.14	1.84	1.67	1.48	1.33
205	2.69	2.24	1.91	1.75	1.55	1.40

VOLUMETRIC EFFICIENCY OF AMMONIA COMPRESSORS

Condenser Pressure, Lb. Gage		Suction Pressure Lb. Per Sq. In. Gage 0	10	20	30	40
120	A.	0.77	0.83	0.87	0.89	0.91
	B.	0.60	0.70	0.77	0.81	0.84
	C.	0.52	0.65	0.72	0.77	0.80
160	A.	0.74	0.80	0.83	0.86	0.88
	B.	0.54	0.65	0.72	0.76	0.80
	C.	0.44	0.58	0.66	0.72	0.75
200	A.	0.71	0.77	0.81	0.84	0.86
	B.	0.49	0.61	0.68	0.72	0.75
	C.	0.37	0.52	0.62	0.67	0.71

A, No clearance. B, 4 per cent clearance. C, 6 per cent clearance.

Precautions To Observe When Operating Gates at a Dam

By L. W. Wyss

If for any reason a gate is thought to be frozen fast or some other obstruction prevents its free operation, it is well to try it by hand control, unless the operator is sure that he can handle the situation with the power without causing any damage. Hoisting cables or chains may become kinked or twisted. In a case where two chains or cables are used on a heavy gate, this may strain the gate if the twisted cable or chain carries the full weight, or the cable or chain may break, leaving the weight on the other side, which may also strain the gate. These kinks or twists are usually caused by unnecessary slack when the gate is resting at the bottom of its travel, so it is well to avoid this slack. It is sometimes advisable to attach spare chains or cables to gates in order to recover them, in the event

of failure of the regular hoisting chains or cables. This is easily done and may save unnecessary wasting of water, or lowering the head-water elevation in order to recover the gate. When chain or cable-operated gates are raised to do such work as painting the gate or replacing gaskets, the workmen should not depend on the operating chains or cables, if their breaking would result in accident or loss of life. This is because the chains or cables may have been strained at some time and therefore cannot be considered dependable. Props, blocking or extra cables and chains will assure safety-first. When working on an electrically operated gate, where moving of the gate might result in accident, tag or lock the motor switch. This is especially important where gates are controlled from a distant point. Ice in exposed gear wheels may damage hoists if not chopped out. If no limit switches are provided on power-driven gates, the operator should be careful to prevent overtravel, which may result in damage, and if limit switches are provided it is well to inspect them occasionally.

Advantage must be taken of favorable load and water conditions, when work such as painting or replacing gaskets on gates is done. If a waste gate must be raised wide open, it should, of course, be done when water is plentiful, while if the head water must be lowered, it should be done at some period when the least inconvenience will result. The load dispatchers of the larger systems usually supervise such matters if the station capacity will be affected.

Dams built on soil foundations generally require more care than those built on rock. The correct supervision of wasting water may help considerably to prevent undermining or washing out. If the gates are all opened uniformly during flood periods, it will often be advantageous in preserving the dam. Then, again, at some dams there may be a certain section of gates located so that if the flood water is discharged through them it will result in a minimum of eddies or whirlpools; this will also help preserve the dam. Dams on soil foundations often have tumble bays for the waste gates to discharge into, to relieve the concrete of wear as well as to prevent eddies.

The reservoir capacity may often serve to relieve the dams from discharging the peak of a flood by wasting enough water in advance of the flood peak to lower the reservoir elevation and then let the peak of the flood bring the head back to normal. At some dams no advantage will be gained in doing this, but at others excessive floods wash away banks and endanger the dam structure, while at still others the spillway is not cabable of discharging the peak of a flood, or the high tail water may flood the power house. The foregoing method of handling a flood may also be used to benefit a downstream dam, such coöperation being valuable regardless of whether the ownership is allied or not.

Paper Belting Made in Germany

During the latter part of the late war considerable was published in the newspapers regarding the scarcity of leather and rubber in Germany and of how the people were wearing paper clothing. Probably these newspaper reports were not exaggerated, as would seem to be indicated by the two samples of belting that have just been received.

In Fig. 1 is shown a sample of a 2½-in. "Sackolin" belting, ¼ in. thick. It came from Carl Scheip, Cologne, on the Rhine, who operates a supply house and carries, among other commodities, rubber articles, transmission belts, etc. This belting is made up of six plies of spun woven paper fiber. Two plies are stitched together and the thickness of the finished belt depends upon the number of these double plies. The belt shown in the sample is made up of three two-ply thicknesses as shown. One side is blackened and is the driving side. According to printed instructions, this kind of belt will transmit but 60 per cent of the load that a leather belt of the same thickness and width will, other conditions being the same. It cannot be tightened as much as a leather belt, and the instructions state that it is "absolutely" necessary to apply often the belt dressing called "Tush Durch" to the pulley side of the belt.

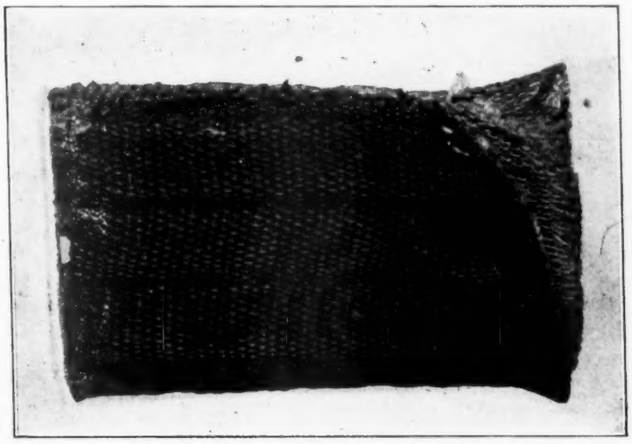


FIG. 1. A 2½-IN. BELT MADE OF WOVEN PAPER FIBER

The belt shown in Fig. 2 is of wire-link construction surfaced with twisted fiber windings, as shown. Each metal link is made of one piece of wire and bent in a continuous 1¼-in. link, in this instance, forming a belt section 5¼ in. wide. Through the center of each link section is passed a paper strip about $\frac{1}{16}$ in. thick and ⅜ in. wide, around which the twisted paper fiber is wound, each winding coming between two of the link windings. The various link sections are secured together by a stiff wire passing through the ends of the loop formed by the link winding. The outer end is bent parallel with the edge of the belt and then bent over the following tiepin, thus tying the belt together. The paper windings are for the purpose of providing a better nonslipping surface than would be afforded by the wire itself.

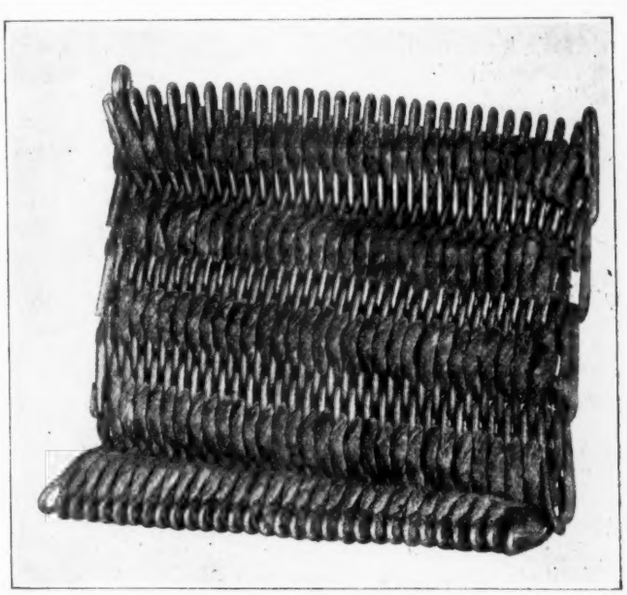


FIG. 2. BELT CONSTRUCTED OF WIRE LINKS AND TWISTED PAPER FIBER

Explanation and Measurement of Power Factor

By VICTOR H. TODD

Power factor is defined. Why volts times amperes are not always the watts in an alternating-current circuit, the effect of low power factor, and the actual measurements of power factor in single-phase, two-phase and three-phase circuits are discussed.

FIG. 1. SWITCHBOARD-TYPE POWER-FACTOR METER

IN a direct-current circuit only two instruments are required to measure the volts, amperes and watts. A voltmeter will indicate the electromotive force in volts, an ammeter will give the current in amperes, and the product of the two readings will represent the watts. In an alternating - current circuit, however, this is not always true, as it is necessary to multiply the product of the volts and amperes by another number, called the "power factor," in order to determine the watts. The power factor may vary from 0 to 1, or, since it is often expressed in per cent, from 0 to 100 per cent. As will be shown later, the values between 0 and 1 may be known as lagging or leading power factor.

The simplest way to determine the power factor of a load is by the use of a power-factor meter such as is shown in Fig. 1. This gives a continuous indication, reading directly in per cent. power factor. It shows if the power is positive (from generator to load) by indicating in the upper half of the scale, and negative (load to generator) by indicating in the lower half, and if the current is lagging or leading the voltage. In other words, if the alternator is supplying power to the system, the instrument will read the power factor on the upper scale, but if the alternator is taking power from other generators on the system and operating as a synchronous motor, the meter will indicate the power factor on the lower scale. A power-factor meter of the portable type is shown in Fig. 2. This reads from 40 per cent. lag to 50 per cent. lead and includes all the values commonly met in commercial practice. Power-factor meters may be had to operate on single-, two- and three-phase circuits. They are generally wound for 5 amperes in the current coil and 110 volts on the potential coil, and therefore require current and potential transformers on circuits above these ratings.

To illustrate the use of power factor in the calculation of watts, assume that a single-phase induction motor is run from an alternating-current source, with instruments connected as in Fig. 3. Assume that the voltmeter reads 110, the ammeter 9 and the power-factor meter 0.80. The product of volts and amperes is $110 \times 9 = 990$, but this is not watts; it is called "apparent watts" or "volt-amperes." The power-factor meter indicates that the true watts are only 80 per cent. of the apparent watts; so in this case $990 \times 0.8 = 792$ true watts, or simply watts. This would be the amount indicated on a wattmeter. In dealing with quantities of sufficient magnitude, the units used are the kilowatt (1000 watts) and the kilovolt-ampere (1000 volt-amperes).

As is well known, the voltage and current values of alternating current are continually varying between 0 and maximum. If the current and voltage waves pass through the values of 0 and maximum at the same instants, they are said to be "in phase" and then the watts are equal to the volt-amperes. This condition is shown graphically in Fig. 4, where it will be seen that the current wave coincides with the voltage wave in both 0 and maximum values. This is the case when the power factor is 100 per cent. or unity. Under these conditions the watts at any instant are proportional to the product of the instantaneous values of current and voltage at that instant.

In an inductive circuit, the current change does not follow the change in voltage instantly, but "lags" behind the voltage. This condition is shown graphically in Fig. 5, where the full line represents the voltage, and the dotted line shows the current lagging 60 deg. behind the voltage. Now, the current and voltage are said to be "out of phase" and the angle of phase difference is 60 degrees. It will be noticed that there are now conditions when the voltage is in one direction and the current is in the opposite direction, and the product of these instantaneous values gives what is known as negative power. Negative power may be considered as power that has been delivered to the load, but is returned unused from the load to the generators or transformers, consequently does no useful work and only adds so much more load to the system. Obviously, this is the objection to low power factor; it is uneconomical and inefficient to transmit a certain amount of power with its attendant losses in line and transformer, and then return a part unused. The excess of positive power over negative power appears as useful energy in the load; it is the true wattage as indicated or recorded by a wattmeter or watt-hour meter. A 60-deg. phase angle between the voltage and current is equivalent to a 50 per cent. power factor.

FIG. 2. PORTABLE-TYPE POWER-FACTOR METER

In a circuit that acts as a condenser, the current leads the voltage, but as far as the effect of power factor on the relation of watts and volt-amperes is concerned, the result is the same with either a lagging power factor or a leading power factor.

Induction motors, arc lamps, alternating-current weld-

ing outfits and furnaces are examples of inductive circuits; synchronous motors and converters operating with their fields overexcited, and unloaded high-tension transmission lines are examples of condensive circuits.

Fig. 6 shows graphically the condition of a circuit when the current lags 90 deg. behind the voltage. The

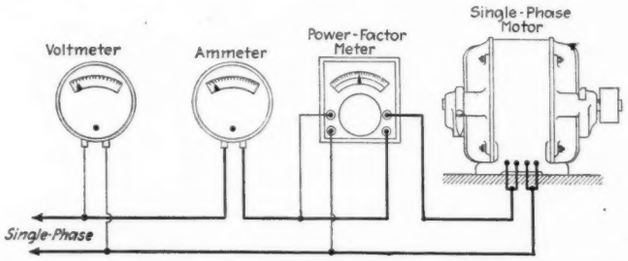


FIG. 3. VOLTMETER, AMMETER AND POWER-FACTOR METER CONNECTED IN A SINGLE-PHASE CIRCUIT

positive power is now equal to the negative power; that is, the power is being returned from the receiving circuit as fast as it is delivered. This condition is called 0 power factor. In this case, no matter how much the voltmeter and the ammeter may read, their product when multiplied by 0 power factor will give 0 watts. For instance, in our first example, Fig. 3, if the power-factor meter had indicated 0, then $110 \times 9 \times 0 = 0$, and a wattmeter or watt-hour meter connected in circuit would not indicate or record irrespective of what the voltmeter and ammeter might indicate. This condition is seldom, if ever, encountered in commercial work. About the

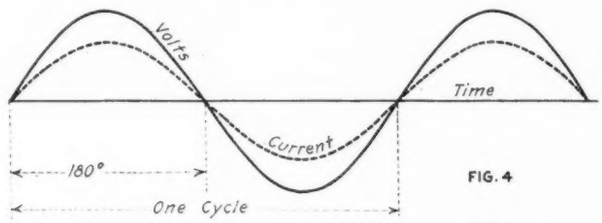


FIG. 4

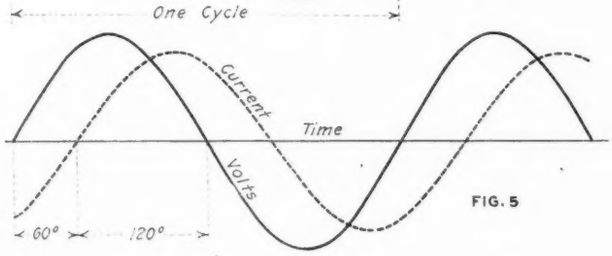


FIG. 5

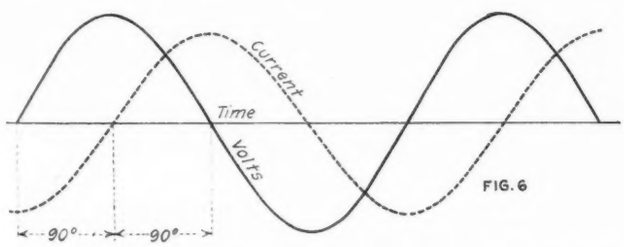


FIG. 6

FIGS. 4 TO 6. CURVES SHOWING DIFFERENT RELATIONS BETWEEN VOLTAGE AND CURRENT

nearest approach is in the case of an induction motor running unloaded, when the power factor may drop to 15 or 20 per cent., but never to 0. There must always be enough excess of positive over negative power to supply the running losses in the machine, consequently the power factor can never drop to zero in an induction motor.

If it takes 100 amperes to transmit a given load at 100 per cent. power factor, then it will take 200 amperes to transmit the same power at 50 per cent. power factor, the voltage remaining the same. Consequently, the generator, transformers and lines must be larger to carry this increased current safely. The losses are greater

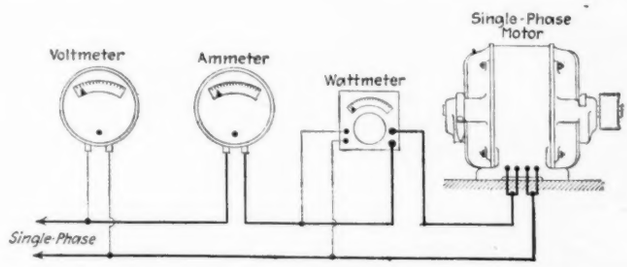


FIG. 7. VOLTMETER, AMMETER AND WATTMETER CONNECTED IN A SINGLE-PHASE CIRCUIT

in the generators, transformers and lines, since the heating loss is proportional to the square of the current, regardless of whether the current is "in phase" or "out of phase" with the main voltage. Still, the watt-hour meter will not record any more in the second case than in the first, although more expensive generating and transforming apparatus is required, and the loss is much greater in delivering the power in the second case than in the first. Evidently the customer who uses a certain load at a low power factor should pay more than a customer who takes the same load at a high power factor. In some cases power companies penalize the customer for low power factor by charging a higher rate per kilowatt-hour, the rate increasing as the power factor decreases. In some cases the customer is given a bonus for keeping a high power factor, the rate per kilowatt-hour decreasing as the power factor increases. Another method is to meter the active volt-amperes (watts) and the reactive volt-amperes (returned watts) and charge a separate rate for each, explaining to the customer that the reading of the reactive volt-ampere-hour meter is waste and can be eliminated by a proper manipulation of load.

The power factor is equal to the cosine of the angle of phase-difference between the voltage and current. In commercial work it is seldom necessary to know the actual angle of phase-difference, as the power factor can be calculated from the readings of a voltmeter, ammeter and wattmeter or read directly from a power-factor meter, such as shown in Fig. 1 or Fig. 2. Power-factor meters have the advantage of indicating if the current is lagging or leading, as this cannot be determined from the voltmeter, ammeter and wattmeter reading method. The following paragraphs give the methods of determining the power factor of various circuits:

Single-Phase, Two-Wire: A single-phase power-factor meter connected as in Fig. 3 will indicate the power factor of the circuit. If the voltage or the current is above the capacity of the meter, select a voltage transformer that will give about 110 volts on the secondary and a current transformer that will give between 1.5 and 5 amperes secondary on normal load. If, after connecting, the pointer indicates in the lower half of the scale, reverse the potential-coil connections. In Fig. 3, if we substitute a wattmeter for the power-factor meter, as in Fig. 7, it will indicate the true watts. Then

$$\text{Power factor} = \frac{\text{true watts}}{\text{apparent watts}} = \frac{\text{wattmeter reading}}{\text{volts} \times \text{amperes}}$$

Assume that the meters in Fig. 7 read 110 volts, 9 amperes and 792 watts. Then 110×9 gives 990 ap-

parent watts; and 792 divided by 990 gives 0.8, which is 80 per cent. power factor.

Single-Phase, Three-Wire: In this case, a three-wire current transformer should be used. This has two primaries and one secondary; a primary should be connected in each outside wire of the circuit, and the secondary to the wattmeter and ammeter or the power-factor meter. The voltage should preferably be taken across the outside wires. The connections are shown in Fig. 8.

Two-Phase, Four-Wire: The power factor may be taken on either phase with a single-phase power-factor meter, or by the voltmeter, ammeter and wattmeter method in exactly the same way as for a single-phase circuit. If the load is balanced, such as in the case of a two-phase motor load, the power factor may be measured on one phase and assumed to be the same on the other. If the load is unbalanced, the power factor must be taken separately on each phase. In reporting the power factor of an unbalanced two-phase load, it is preferable to state the power factor of each phase rather than attempt to strike an average. A two-phase power-factor meter will not give the average power factor, on an unbalanced circuit. They are designed for use on balanced loads only.

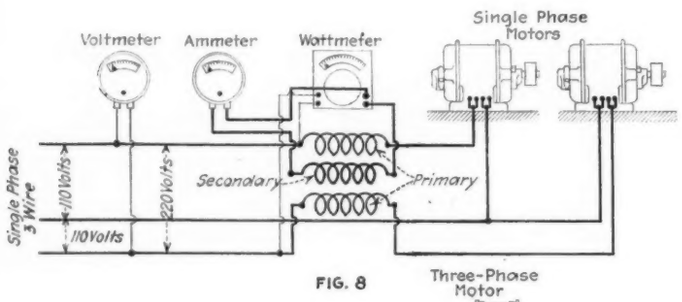


FIG. 8

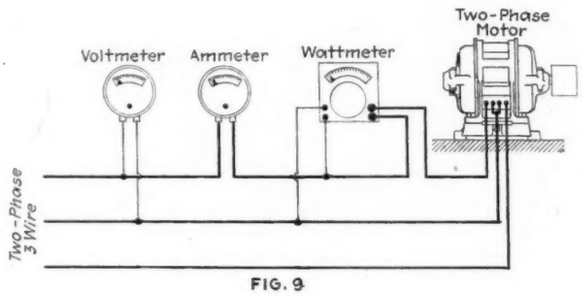


FIG. 9

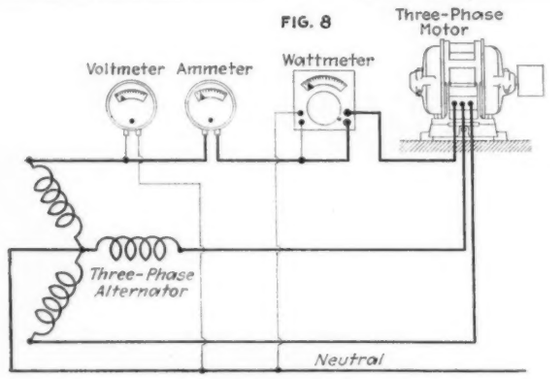


FIG. 10

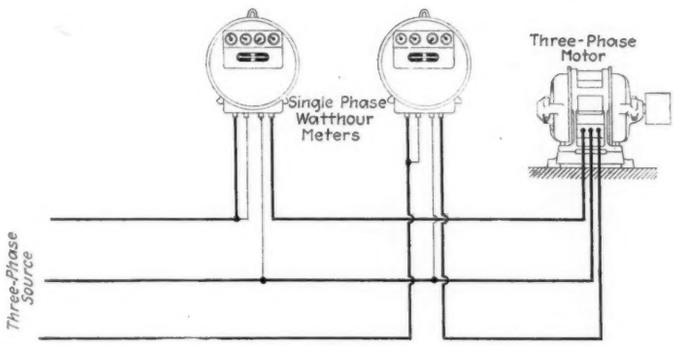


FIG. 11

FIGS. 8 TO 11. INSTRUMENT CONNECTION ON DIFFERENT CLASSES OF CIRCUITS

Two-Phase, Three-Wire: In this the power factor is determined in a similar manner to the single-phase. Care must be taken that the current coil is inserted in an outside wire, not the common, and that the voltage is taken between that wire and the common, not across the outside wires. The proper connections are shown in Fig. 9.

Three-Phase, Four-Wire: If the neutral of a three-phase circuit is available, the current coil may be connected in one line and the voltage taken from that line to the neutral. This applies to either a single-phase power-factor meter, or the voltmeter, ammeter and wattmeter method. The connections are as shown in Fig. 10. If the load is unbalanced, it is necessary to install three single-phase power-factor meters. A three-phase power-factor meter will not record the average power factor of an unbalanced three-phase load.

Three-Phase, Three-Wire (Balanced): A three-phase power-factor meter is preferable to find the power factor in this case. If a single-phase meter is used, it must be specially calibrated so that it reads 100 per cent. when the current and voltage are 30 deg. out of phase, because in a three-phase circuit, the current in each wire is 30 deg. out of phase with the voltage as measured between that wire and either of the others, at 100 per cent. power factor. Two single-phase wattmeters may be used to calculate the power factor, and two single-phase watt-hour meters may be used to calculate the average power factor for a long period of time; a month for instance. If two single-phase watt-hour meters are connected as in Fig. 11, they will record the total load. At 100 per cent. power factor both meters will record equal amounts, but as the power factor decreases, one meter will record more than one-half the load and the other less. At 50 per cent. power factor, one meter stops, while the other records the full load. Below 50 per cent. power factor, one runs backward, while the other records more than full load. The total kilowatt-hours consumption is the algebraic sum of the two readings in any case.

The power factor is determined by locating the ratio of the smaller to the larger reading on the curve in Fig. 12. The negative side of the curve is for power factors below 50 per cent. and the positive side for power factors above 50 per cent. Assume that the two watt-hour meters in Fig. 11 both start at 0000. At the end of a month's time assume the reading on one meter to be 4000 kilowatt-hours and the other 2400. Their sum would be 6400 kilowatt-hours, which represents the total power consumption. The ratio of the smaller to the larger reading is 0.6, that is, $2400 \div 4000 = 0.6$. As both readings are positive, it shows that the average power factor has been above 50 per cent. Locating where the 0.6 line in Fig. 12 is crossed by the curve, we find that the point is 93 per cent., which represents the average for the month.

At the end of the next month assume that the first meter reads 6000 and the other 1900. As the second meter reads less than before, we immediately know that it was running backward and that the average power factor was below 50 per cent. The first meter recorded

6000 — 4000, or 2000 kilowatt-hours, and the other recorded 1900 — 2400, or —500 kilowatt-hours. The total consumption for the month would be 2000 — 500, or 1500 kilowatt-hours. The ratio of the smaller consumption to the larger is — 500 ÷ 2000 = — 0.25. Locating, on the negative side, where the curve crosses the 0.25 line, we find that the average power factor for the month has been 0.34, or 34 per cent. It is very important that this method be used only on balanced loads, as

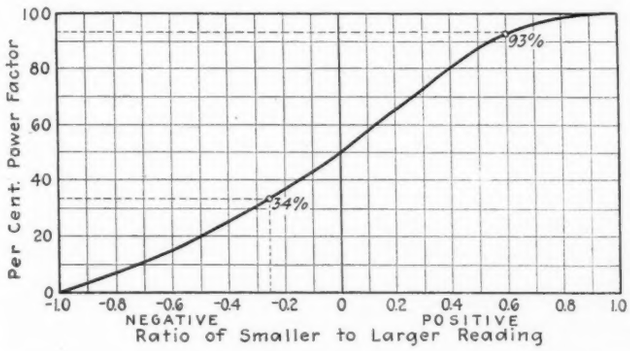


FIG. 12. CURVE SHOWING RELATION RATIO OF WATTMETER READING AND POWER FACTOR

an unbalancing of the load produces similar effects to a varying power factor.

Three-Phase, Unbalanced: The power factor of an unbalanced load may be defined as the ratio of the true watts to the apparent watts; but the apparent watts is a very elastic quantity. The most favored definition is that the apparent watts is the sum of the apparent watts of each phase, and the apparent watts of each phase is the product of the amperes in a wire and the voltage between that wire and an artificial neutral.

To measure this properly requires the use of three

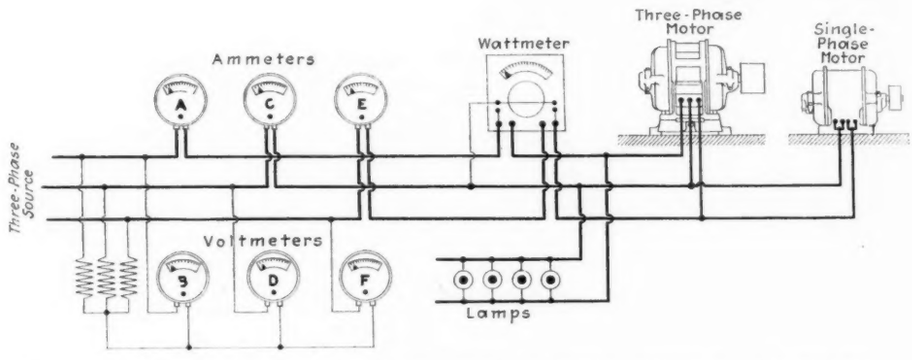


FIG. 13. LOAD AND METER CONNECTIONS ON AN UNBALANCED THREE-PHASE CIRCUIT

voltmeters, three ammeters and a polyphase wattmeter with connections as in Fig. 13. The formula is as follows:

$$\textit{Average power factor} = \frac{W}{B \times A + D \times C + F \times E}$$

Assume $W = 1500$, $A = 5$, $C = 6$, $E = 7$, $B = 100$, $D = 110$, and $F = 120$; then substituting in the formula,

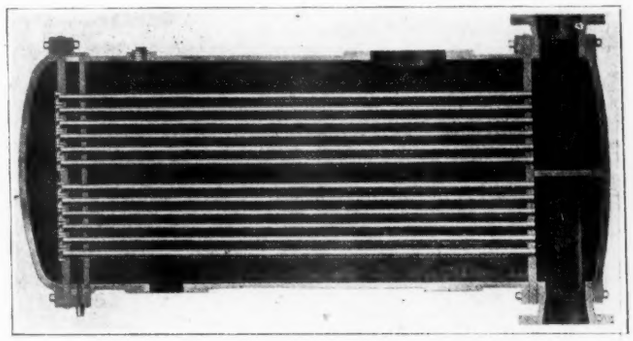
$$\textit{Average power factor} = \frac{1500}{(100 \times 5) + (110 \times 6) + (120 \times 7)}$$

$$= 0.75 \text{ or } 75 \textit{ per cent.}$$

Owing to the importance of the measurement of power factor in a three-phase four-wire unbalanced circuit, which is the most commonly met case in commercial work, there is being developed at the present time an "apparent voltammeter" which will indicate this quantity on a three-phase circuit, thus requiring only two instruments to determine the power factor, and its calculation will then be as simple as for a single-phase circuit.

New Wheeler Auxiliary Tube-Plate Condenser

It was recently brought up at a meeting of marine engineers that many of the ships now in service are experiencing trouble with leaky condensers. These leaks have been almost invariably traced to the stuffing-box between the tube and the tube plate. It has been found that in spite of the kind of packing used, some leakage is practically unavoidable owing to the expansion and contraction of the tube with temperature change.



CONDENSER WITH AUXILIARY TUBE PLATE

The illustration shows a new type of condenser developed by S. Morris Lillie, and manufactured by the Wheeler Condenser and Engineering Co., Cateret, N. J. This condenser is used chiefly in connection with salt circulating water on board ship or in regions where the water that is used for circulating purposes would be bad for boiler feed in case of leakage into the condenser and consequent mingling with the condensate.

The tubes are tightly expanded into the right-hand tube plate, which eliminates the possibility of leakage at this end. At the other end the tubes are provided with the standard ferrules and condenser packings. The packing permits the tubes to expand freely and yet maintains an almost leakless joint. It is therefore at the left-hand end that leakage occurs, if at all.

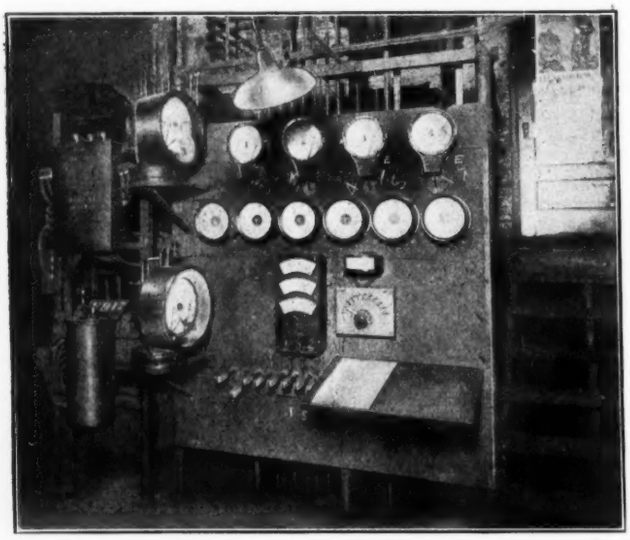
At the left end of this new condenser a thin auxiliary tube plate or baffle is provided, through which all the tubes are passed. The holes in this plate are of such size as to make a sliding fit with the tubes. It is, obviously, not necessary that these joints be water-tight.

In case of leakage of circulating water through the ferrules and packing, such leakage immediately drops to the bottom of the compartment between the two tube plates, and is then carried off by the drain shown at the bottom, to which is attached either a small direct-acting condensate pump or a vacuum trap.

Boiler-Room Instrument Boards

The necessity of having measuring devices for the purpose of controlling processes is gaining recognition, but much uncertainty still exists as to the benefits derived therefrom. Obviously, mere possession of measuring and indicating instruments is not sufficient to secure economic operation. Neither can reading and recording the indications possibly improve the operating efficiency unless the indications are understood, the effect on the results interpreted, and steps taken to adjust the operating conditions in accordance with established relations between conditions and effects. Unless the management is prepared to make proper use of the instrument equipment, the investment in such is of doubtful value.

The careful and thoughtful use made of instrument equipment invariably produces quick and gratifying results. A report of one of the power supervisors on the



BOILER-ROOM INSTRUMENT AND CONTROL BOARD

The board serves two separate boiler rooms. Two recording steam-flow meters are on the left, and each serves a main header in each boiler room; of the four recording thermometers, top row, there are two for each boiler room, where one serves the heater and one the economizer. Below are six indicating steam-flow meters. Under this row a three-in-one draft gage serves all boilers by means of selective valves operated by pressing any lever of the group under the gage. The pyrometer alongside the draft gage is used for the exit gases in the same way. The stoker and fan speed controls are shown.

effect of the installation of some instruments permitting him to control more accurately the operating processes is interesting, as it is typical of all such cases.

. . . it is evident that in the four months preceding the installation of a boiler-control board, the savings on fuel due to various steps taken averaged $435 per month, while in the four months following the installation of the instruments the savings, computed on the same basis, averaged $1,135. In other words, the increased saving, due solely to the intelligent use of instruments on the boiler-control board, was $710 per month, or $8,620 on the annual basis, which means that the expenditure of $2,080.46 for instruments of the board is an investment which in this case yields over 400 per cent. return.

The illustration shows the boiler-room instrument and control board as devised by Walter N. Polakov, the well-known consulting engineer. In passing it should be noted that the plant in question is a comparatively small mill boiler house consuming between 150 and 200 tons of coal per week.

The next question that comes up in connection with means for investigating existing operating efficiency and development of better methods is: What instrument equipment is necessary and sufficient for the purpose? Evidently, it is not possible to specify a set of instruments that meet the requirements of any plant. The character of generating equipment, its layout, service conditions, specific problems, etc., determine actual selection. In a paper before the 1918 spring meeting of the A. S. M. E., Mr. Polakov said:

While the generation of power, and more specifically of steam, is the domain of the scientifically trained engineer, power-plant practice is conspicuous by the lack of accurate measurement of conditions and results.

Unless the results obtained are known, no opinion as to perfection of operation can be sound; furthermore, the practice is necessarily wasteful unless means are available to observe the conditions under which the process is performed. All instrument equipment of the boiler house can therefore be grouped into two classes: (1) Recording the results; (2) showing the conditions.

A plant of which it is not known how many pounds of coal are used per thousand pounds of steam, how the load is distributed among the units and throughout the day, etc., wastes fuel by necessity. The knowledge of these data does at least open the eyes of those responsible for its success, and further progress is thereby made possible.

The first group of boiler-room instruments thus comprises: *Quantity*—Recording coal scales, recording steam or water meters, coal calorimeter and moisture scales, feed-water thermometers, steam pressure gage and thermometer.

The second group of instruments is intended to direct the processes by controlling conditions: Flow indicators, draft gages, flue-gas thermometers, flue-gas analyzers.

Any investment in instruments is a pure waste of money and leads to demoralization unless means are provided for training men in their proper use, stimulation of men in their proper use, and complete, exact and continuous recording. The location and arrangement of instruments shall be such as to permit simultaneous readings and their comparison, permit plain view of units from instrument board and reverse, afford the opportunity to use one instrument for diverse units, eliminate unnecessary fatigue of observing scattered instruments, and assure ease and simplicity for testing.

These requirements are combined in the type of instrument boards shown herewith. A fallacy of economizing on instrument equipment or ignorant attempts to select only "the most important" ones has only one rival in absurdity—the tendency of installing instruments without giving the employees the opportunity to use them to advantage. Obviously, the operating men have no time, no ability for research work and little inducement to carry out investigations, standardization methods and set tasks. It should be the duty, therefore, of the management to render them necessary training and to assume responsibility for results.

The Bhakra Dam, which it is proposed to build across the Sutlej River, India, in the Bhakra Gorge, about forty miles above Rupar, the headworks of the existing Sirhind Canal, will be, says the *Madras Mail*, 395 ft. high from foundation level to roadway, and will be the highest dam in the world. The depth of water in front of the dam will be about 375 ft., good rock for the foundation having been found near the surface. The length of the top of the dam will be 1,015 ft. The water to be stored by the dam in the month of August annually will be 2½ million foot-acres.

EDITORIALS

Preventing vs. Correcting Low Power Factor

NUMEROUS surveys of industrial alternating-current power loads have found power factors as low as forty-five per cent and with sixty-five per cent as a common value. Under such conditions the voltage regulation is most seriously affected, owing to the excessive line drop and also to the demagnetizing effect of the lagging current upon the alternator field poles. Poor voltage regulation at the motors in all cases causes a reduction in production and not infrequently also lowers the quality of the product. Therefore, it is desirable that the voltage be maintained as constant as good engineering dictates, consequently the power factor of the load must be maintained at a fairly high value.

When the operating engineer considers improving the power factor of the system in his charge, he has two directions in which to turn his attention—the preventing of poor power factor and the correcting of it. Either one or a combination of both may be the solution of the problem. The prevention of low power factor is obtained by the proper application of motors, while power-factor correction is brought about by the use of corrective means such as synchronous machines used under various conditions, or by the installation of static condensers. One of the most serious causes of low power factor is over-motoring, and it has been well established by many power-load surveys that a large percentage of our industrial plants are over-motored. Over-motoring in the past has no doubt been due largely to the lack of reliable data on the power requirements for different classes of industrial machinery, and motors were installed that would be sure to do the work, which in general were anywhere from twenty-five to fifty per cent too large. However, reliable data on power requirements have now been obtained on most standard industrial machinery, and in these cases there is no engineering reason why such machinery, when driven individually, should not be properly motored. Where machines are driven in groups the problem takes on a different aspect. If the motor has capacity sufficient to drive all the machines in the group, which it must have in most cases, and if at times only a small portion of the machines are operated, the motor will be operating under-loaded. Then if the motor is of the induction type, it will be operating at a low power factor. Here is probably one of the best arguments for the use of synchronous motors, when they can be properly applied, on group drives. If only unity power-factor motors are installed, they will, at full load, operate at one hundred per cent power factor, and even under this condition help to improve the power factor of the industrial load. If the load is reduced on the motor, it will then begin to supply to the system a leading current that will help improve the power factor of the inductive load. Where the power factor of the average induction motor drops to about sixty-five per cent lagging at forty per cent load, that of a unity power-factor synchronous motor drops to fifty per cent leading, the latter a very desirable feature in most power systems.

Before power-factor corrective means are adopted, every effort should be made to prevent low power factor, by having the motors properly applied. Where motors of too large capacity have been installed, a power survey will frequently indicate how they can be exchanged so that they can be more nearly loaded to their full capacity; especially is this true where extensions are being made to the plant. Only after this has been done, or it is established that the low power factor cannot be prevented economically by a rearrangement of the motors, should corrective means be applied. Although the application of synchronous motors or static condensers will improve the power factor of the system as a whole, they do not prevent under-loaded induction motors from operating at low efficiency and low power factor, both of which increase power costs.

A National Society of Engineers

THERE is every likelihood of the formation in the early future of a broad national society which shall mobilize the engineers of the country in order that the engineering and allied technical professions may become a more active national force in economic, industrial and civic affairs.

The progressive element in the four great professional societies began to question, under the spur of criticism, whether organized action of engineers of all kinds for the public good and their own welfare could not be carried to a greater length than these specialized, exclusive and professional bodies were able or ready to go.

A Committee on Aims and Organization was appointed by the Mechanical, and Committees on Development by the Civil, Electrical and Mining engineers, out of which grew a Joint Conference Committee composed of representatives of the four societies named. This Joint Conference Committee recommended the formation of a single comprehensive organization, the purpose of which should be "to further the public welfare wherever technical knowledge and training are involved, and to consider all matters of common concern to these professions."

This great national organization of engineers is to be built from the bottom up, the plan being to organize a large number of local societies to which anybody who has legitimate interest in engineering may belong, and to tie these together in a national body, or federation, made up of representatives from the local bodies and from the professional and regional societies which are too large to be classed as locals. The relation of these societies, like the American Society of Civil Engineers, the American Institute of Electrical Engineers, the Institute of Mining and Metallurgical Engineers, and the American Society of Mechanical Engineers, to the larger organization should logically be the same as though that more heterogeneous organization had been formed first, and the specialized and exclusive institutes and societies crystallized out of it; but previous existence gives the present societies opportunities that will make their relations to the larger body more parental than filial. It should be through the activities of their local sections and affiliates that the constituent locals are incited into being and nurtured through their formative stages. They may need to finance the National Association in its

early stages, although a moderate per capita tax upon the upward of one hundred thousand professional and semi-professional engineers available as members ought to provide ample funds for ordinary activities.

For the first time in history the governing boards of the Four Founder Societies, as they are called, met in joint session on Friday, January twenty-third, approved the recommendations of the Joint Conference Committee and authorized that committee to proceed to bring the national organization which it recommended into being. The next day the Council of the American Society of Mechanical Engineers approved and adopted the report of the Joint Conference Committee, authorized the society's representatives on the Joint Conference Committee to take the necessary steps to carry out the recommendations of the report and voted a generous appropriation for the use of the committee. The Civil and the Electrical engineering societies have already discussed the report in open meeting, and the Institute of Mining and Metallurgical Engineers is to discuss it in February.

All of the Four Founder Societies appear to be committed to the adoption and carrying out of the recommendation of the Joint Conference Committee for a National Organization, by the unanimous joint action of their governing boards on January twenty-third. This joint meeting of its four parent societies was called by Engineering Council, which was begotten by the civil, mechanical, electrical and mining societies out of United Engineering Society, which, being simply a holding company concerned with the administration of the buildings and property owned in common by the constituent societies, was not thought to be competent to undertake those activities, which appeared to belong to or to afford opportunities to engineers collectively rather than to any particular society. Council proved a precocious offspring, and before its parents realized what it was up to had committed them to a debt of twenty-five thousand dollars and laid out a program for the coming year which it would cost sixty thousand dollars to carry out. The family consultation was to increase its allowance or curtail its activities.

The ultimate effect of the action of the meeting upon the fate of Council cannot be foretold. As a medium for impressing the engineer upon current happenings, for obtaining recognition of the profession and organizing opportunities for its greater service, the larger, more democratic organization appears to offer the greater advantages. There may still be some functions that the more rigidly professional societies can better exercise in common through Council.

There is already in process of organization an engineering society upon the broad, democratic, inclusive plan under discussion—the American Association of Engineers. In a comparatively short time it has acquired a membership of over ten thousand. It deals with the human as well as the technical side of the profession. Its chapters are widely distributed geographically.

If it were so persuasive and convincing as to join the whole engineering profession and craft under its banner, it would be the big national society toward which we are all looking. What will be the effect of the new movement upon its growth and fate? Will it join the other societies in encouraging the members of its local chapters to join the community groups and through them the rival national organization, even though such a course imperils its own existence? It has already invited the coöperation of the older societies in a way that indicates that it is willing to do its part in the evolution of the large idea and the carrying out of the larger purpose.

Watch the Diesel

SELDOM has there been assembled on this side of the Atlantic so many recognized Diesel-engine experts as were seen at the recent meeting of the Society of Automotive Engineers in Philadelphia. That the discussion lasted over four hours is an indication of the thought being given to the subject, and it is quite evident that engineers are fully alive to the possibilities of the oil engine for certain classes of service and that much may be expected in the near future. Although the meeting brought out differences of opinion as to details, there was general agreement on the more important points. For instance, it was conceded that for some time at least the field for the marine Diesel will lie in its application to cargo vessels up to a maximum of twelve or thirteen thousand tons with speeds up to about fourteen knots. The popular size of units will be from one thousand to fifteen hundred horsepower, although where necessary they will be built up to twenty-five hundred or three thousand horsepower for the larger ships. The four-cycle engine now predominates, although it was prophesied that American designers, profiting by the mistakes and experiences of European builders, were on the way to overcoming certain features that caused trouble with the two-cycle type for marine service and that ultimately this type would come into its own.

It seems, also, the consensus of opinion that the auxiliaries should be independently driven.

War conditions gave a big impetus to the oil-fired marine boiler and geared turbine drive. Competition between this combination and the Diesel will be watched with interest. While the war was on ships were needed in a hurry; there were a number of firms in a position to turn out geared turbine sets in large quantity; there was no time for experiment or development. Besides, the limited capacity of our Diesel-engine builders was taxed to equip submarines. But now that condition no longer obtains and the Diesel builders are going after the mercantile business.

On a fuel-economy basis the Diesel will have an advantage at the start, and although it may now be at a slight disadvantage as regards first cost in some instances, this will disappear when standardization and quantity production have been effected. But it is not on fuel economy alone that the decision will be made; it is the greater radius of action and increased cargo-carrying capacity afforded by the Diesel installations that will be determining factors.

But not alone in the marine field are we witnessing growth of the oil engine. In the stationary field for mines and isolated stations in the South and Southwest, for oil-line pumping and irrigation work, and for many light and power plants of limited size in certain sections one notes increased use of this type of prime mover.

For land service consideration is being given also to the two-cycle engine and efforts are being made to increase the efficiency to that of the four-cycle engine. By reducing the excess quantity of air for scavenging and lowering the pressure on this air a small advance has been made, bringing the efficiency within five or six per cent of that possible in the four-cycle engine. In either type an outstanding feature is the sustained economy over wide ranges of load.

It is gratifying to note that the governor of Oregon has signed the bill which places that state in line with the thirteen other progressive states that have adopted the Boiler Code of the American Society of Mechanical Engineers.

CORRESPONDENCE

Field Winding in Opposition Caused Motor to Flash Over

It is always advisable to take nothing for granted when investigating trouble on motors or their control equipment, as the following example will show:

A 3-hp. direct-current 250-volt compound-wound motor operating a paper cutter began to flash over between the brushes on the commutator, at the same time blowing the fuse. It was decided that the motor's field was weak, but on making a drop test with a voltmeter across each coil, they all gave an equal reading. On examination the commutator showed signs of high mica, as it had the usual dark streaky marks found under this condition. Since this has frequently caused flashing, especially when a motor is overloaded, or when accelerated too quickly, the mica was undercut with a file, the commutator sandpapered, and the brush position checked, the latter being found to be correct. This reduced the sparking when the machine was running light, but on taking a cut with the machine, out went the fuses again.

The indications were that the motor was overloaded; so, in order to test it, the belt was taken off and an ammeter placed in the circuit. Holding a plank against

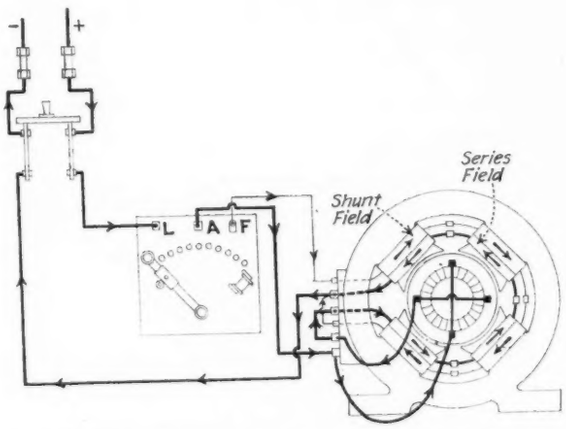


FIG. 1. COMPOUND-WOUND MOTOR SERIES- AND SHUNT-FIELD WINDING IN OPPOSITION

the pulley as a brake, the motor showed no signs of distress at 10 amperes, which was the full-load current. At 16 amperes the sparking was considerable but not excessive, and the flash over did not occur until about 28 amperes had been registered on the meter, representing an overload of about 180 per cent. With the cutter in operation the results were similar; running light the current taken by the motor was about 6 amperes, but on making a cut with the machine the current quickly increased to about 30 amperes, when the commutator flashed over and blew the fuses before the cut was finished.

After spending considerable time in trying to find some irregularity in the cutter to cause the trouble, it was decided that probably the series-field windings of

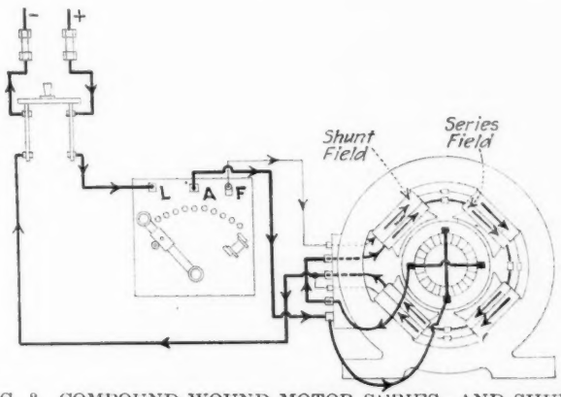


FIG. 2. COMPOUND-WOUND MOTOR SERIES- AND SHUNT-FIELD WINDING ASSISTING

the motor were connected in opposition to the shunt-field coils, as in Fig. 1. On making the change, as in Fig. 2, the results were satisfactory. The current was reduced to 24 amperes on taking the cut, and the motor stood up to this momentary overload without undue sparking at the brushes.

H. WILSON.

Toronto, Ont., Canada.

[For a compound-wound motor, with the series- and shunt-field windings connected in opposition, not to flash over until subjected to a 180 per cent. overload, it must have a very small percentage of compounding.—Editor.]

Capacity of Steam Pipe with Superheated Steam

At a large pulp mill the temperature of the steam was originally 600 deg. F. at the point where it is used in the pulp digesters. The pressure in the boiler house averaged 120 lb. gage, and in the digester house 105 lb. By decreasing the heating surface of the superheater, the steam temperature was reduced to 400 deg. F. The digesters now take the same total quantity of heat, although the actual weight of steam consumed is, no doubt, greater.

I figured that the friction loss would be less using the less superheated steam, but actually this does not seem to be the case. One pound of the 600-deg. steam will occupy more space than the same weight at 400 deg., but

of course more of the latter is required. As the result of my calculation of the friction losses in each case, I came to the conclusion that 20 per cent. less pressure drop should be expected after the superheater tubes had been shortened.

The size of the steam pipe is 10 in., extra-heavy, the total length being 600 ft., with two globe valves. There are no elbows or other fittings to restrict the flow. The weight of steam conveyed by this pipe was 70,000 lb. at the 600-deg. temperature. The pressures given were taken on the 10-in. pipe, and the drop in the superheaters is not considered.

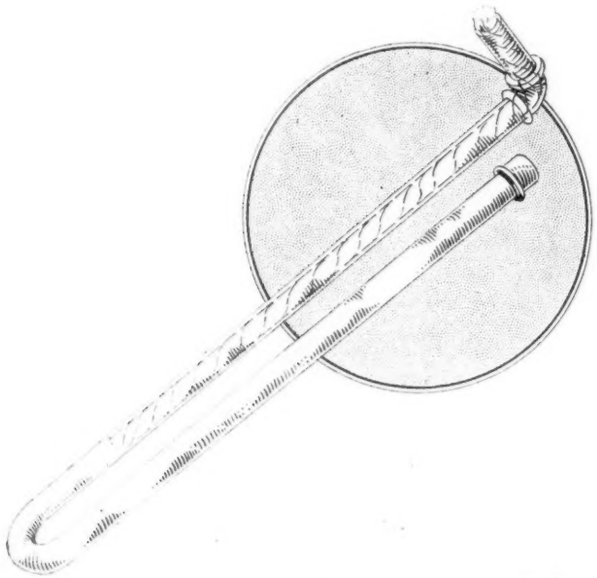
Perhaps some readers of *Power* will throw some light on this subject. B. A. REMOL.

Hawkesbury, Canada.

Non-Upsetting Torch

The torch shown in the sketch is made from a piece of pipe, any size, threaded and bent as shown, capped at one end and an elbow and nipple screwed on the other end.

Before the cap and elbow are screwed on, cotton wicking is entered by means of a wire and pulled



TORCH THAT WILL NOT UPSET

through the pipe until the tail end is about as shown. The projecting end is pulled through the elbow and nipple before it is screwed on. Oil is put in at the end *B* and the end capped.

It is impossible to upset the torch, it is easily carried, and it can be hung up by the hook.

Portsmouth, Ont., Canada. JAMES E. NOBLE.

That "Woman and Machine" Problem

I have read the letter of Jessie E. Minor, page 514, of the Sept. 23, 1919, issue, and also the article in the Aug. 26 issue, in which the statement was made that certain work could be done by a woman and a machine, etc., but I got an entirely different impression from the one expressed by the woman chemist. Having had charge of a manufacturing department employing about 75 men and boys and 50 women and girls for several years, this statement was to me merely an expression of the classification of the work—an expression of fitness and not at all an exclamation of the simplicity of the work or the inferiority of women workers.

In our regular routine work, if a new operation came up, we would classify it with a simple statement: "Give it to a 20-cent girl," meaning that, in our estimation, a girl who was capable of earning 20 cents an hour at other work was capable of doing the work in question. I would say just as quickly, "This work can be done by a 20-cent man" or "That job should be given to a 50-cent woman."

It is obvious that each person has work for which they are particularly adapted, and each class has its particular class of work. For instance, inspecting steel ball bearings is a girl's work. It is light, easily learned, and would be monotonous to most men and boys. Still, it is important. Most girls like a job which is easily learned and which repeats itself continually; its monotony never seems to pall, and they resent any change or transfer to new work, often taking it that the reason is unsatisfactory work and never thinking that the "boss" thinks they may be getting tired of its monotony.

Then, on the other hand, straightening cores or riveting bases of autometers is work much less important and is just as monotonous; but it is best done by a man or boy, because it involves the use of a hammer and this extra physical labor seems to offset the monotony. Punch-press work is usually adapted to men and boys, but if we had a punching job of light work requiring accuracy and cleanliness—for instance, fiber bushings—we would say, "This can be done by a woman," meaning that a woman could do it better than it could be done by a man or boy.

I recall one specific instance: On one operation we had a number of refractory girls whom the man in charge could not control. After we had warned him several times that his girls were not up to standard in behavior or in quality or quantity of work, I remember saying, "That job will take a woman," and consequently we made the change with surprising results. I could go on naming many operations, some requiring initiative, some skill, some accuracy, some reliability, some experience, all being held by women workers with wages on a par with those of the men, as we always worked on the basis, "equal wages for equal work," with a result that much of our work was done by women and girls receiving greater remuneration and doing more important work than many of our men.

Orange, N. J. VICTOR H. TODD.

Why Does the Water Lift When the Safety Valve Blows?

The letters about water lifting in the boiler remind me of an experience with a boiler using a water containing a high percentage of magnesia. Popping of the safety valve or a sudden increase of load would start the water to foaming violently and it would hump up under the safety valve and then level down and repeat until the water lowered four or five inches in as many minutes.

We know it did this, because we would open the surface blowoff on the back end of the boiler. At the same time the water went out of sight in the glass, the skimmer at the rear would blow steam; and when the water came back in the glass, the skimmer would blow water.

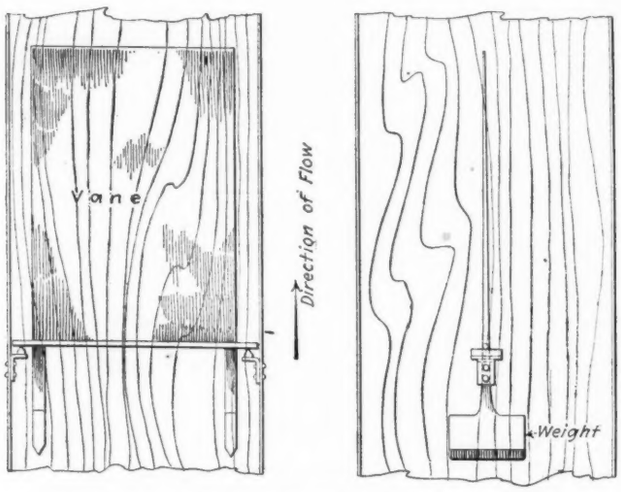
It required quick work to keep enough water to prevent pulling the fire. We kept a couple of wheelbarrow loads of wet ashes handy, and when the foaming started some of it would be dumped on the fire. We finally overcame the trouble. It was good water in one way, as it formed no scale. J. O. BENEFIEL.

Anderson, Ind.

Measuring Small Stack Velocities

I see from the article entitled "Experiments on Stack Performances," in *Power*, Sept. 16, page 464, that the problem of measuring small gas velocities in a stack is still open for solution. From experiments it was found that a vane placed perpendicular to the flow produces eddies and pulsations, thereby preventing good results.

I suggest to place a vane in the direction of the flow, the vane to be pivoted and provided with a counter-



VANE FOR MEASURING STACK GAS VELOCITIES

weight to keep it stable in a horizontal position. Such a vane will offer scarcely any resistance to the flow of gas. If there is no flow of gas around the vane in the direction of the arrow, it will take a certain amount of energy to move the vane from its horizontal position to, say, about five degrees.

If the vane is placed in a current of gas, it will take more energy to move it the same angle from the horizontal, and the energy required will increase with the flow of gas. Knowing the energy required will make a solution of the velocity possible. O. JANZEN.

Half Way Tree, Jamaica, B. W. I.

When Strikes Come

Mr. Speaker, Honored Legislators and all the Lobbyists within the reach of my voice, I rise to interrogate: Just where does labor leave off and capital begin? Who looks after the rights of the disorganized you-an'-me proletariats in between. I belong to the Majority Party of the Men-Who-Pay-the-Bills, and I am getting sore on languid labor and corpulent capital. I don't wear overalls and haven't a silk hat! I can't afford to own a yacht, and I can't afford to go on a strike, although I have worked hard for twenty years.

I have a family and I am more or less respectable. I pay my bills on the first of the month, likewise I pay town, state and national taxes. I have never been confined in a jail or in any institution supported by public funds. I am American born, with all the rights of citizenship, including protection—especially protection at home. I want to know what the Government of the U. S. A., apart from political "necessities," offers as a permanent and orderly cure for these periodic eruptions of strikes. If capital is to blame, what's the remedy? If labor is to blame, what's the remedy?

Or is the whole system rotten? Does the one squeeze the other when the opportunity comes, just because he can? I'm only the Man-Who-Pays-the-Bills. Yet I know my group of men is larger than the other two groups combined. I also know I'm the season-after-season-goat and I want to ask, "Does this Government know I'm the goat and what are you going to do about it?"

A bunch of boomers get a hold on the natural water resources and overcapitalize; I pay twice for water. That's capital. When the weather turns cold, some coal miners in Pennsylvania or Colorado decide to strike —I don't know what for—and there isn't any coal and my baby gets the croup and nearly dies. That's labor.

I'm not jealous of what they get, but I think I ought to get something besides the honor of paying the bills and suffering the inconveniences.

I want to know when this Government, conceived in liberty, will give me a chance to plan my life just a little bit on a permanent basis. I can't strike for a raise in pay—I have to deserve it. I haven't accumulated capital enough to live on without work, and I want to know sure what the price of eggs will be tomorrow morning.

You know who I am. I'm the Average Man. I earn more than $1,300 a year, but not much more. I spend my salary for sane and sensible living. I have ambitions for my boy and girl, maybe a college education, and about every thirty days these two highwaymen, capital and labor, come along and hold me up! Whichever one wins, I lose, and I want a basis.

I say economic theories are all hunkydory, but a little common sense added ain't so bad at that! I say sympathy is all right until we develop professional sym-

THE "GOATS," WHILE LABOR AND CAPITAL FIGHT

pathy grabbers. I say that the unions are all right until they become offensive instead of defensive.

I send my wife and kids on a vacation. Before the vacation is half over I have to wire them to rush back because there is going to be a railroad strike. Their good time is spoiled because they might be injured on the way back, maybe with a brick or a derailment. I have to spend $100 to go to meet them. One hundred dollars—the price of a winter suit and a pair of socks. Why? Because this country knows how to organize a strike, but not how to disorganize one.

And that's my kick, gentlemen. I want to know what you are going to do for us fellows who own the cottages and the Fords and who don't belong to the unions and don't wear overalls and don't own any banks. We buy what labor makes with capital's profit tacked on, an' I want to know where we get a square deal.

Rome, Ga. C. V. YOUNG.

Loose Bolts Caused Induction Motor to Hum

It is not very often that peculiarities develop in a motor from mechanical derangements, which to all appearances seems to indicate that the electrical system is at fault. When such conditions develop, they are not always apparent at first, sometimes requiring an extensive investigation.

A 440-volt three-phase induction motor driving an air compressor gave trouble due to blowing its fuses. The line to the motor ran through conduit and was tested and found to be free from grounds. Next, the winding was inspected, the insulation found to be in poor condition, and it was decided to have the motor rewound. A potential of 600 volts was applied between the winding and frame, which punctured the insulation in a number of places. After the motor was wound and placed in service again, it ran for about a week, when it developed a loud hum. It was taken apart again, and it was found that the end shield bolts on both ends were not as tight as they should have been, but no attention was paid to this until the winding was inspected and found to be in first-class condition. Assembling the motor and tightening the end shields proved that the hum was due to the loose bolts. C. R. BEHRINGER.

Greenville, Penn.

National Engineers' License Law

I have read with interest the many discussions in engineers' magazines on the subject of engineers' license laws, and I wish to say a few words as one who holds an engineer's license in Massachusetts. I have become convinced that it would be advisable to have a law throughout the land making it necessary for all power-plant workers to pass an examination and obtain licenses graded according to their knowledge and ability. I include power-plant workers, because I do not believe the law should include only engineers and firemen, for there is practically as much reason why operators of gas engines and hydro-electric plants should also be licensed. Of course, laborers and helpers should be allowed to work without a license, or they would have no practical way to get enough elementary knowledge to secure one.

I started as hundreds of engineers have, firing in a steam sawmill, and worked my way up to larger plants. In some cases I had to wheel my own coal, fire, run the engine and do my own repair work and all that goes with the care and operation of a steam plant. In one case I fired four boilers and did all the work enumerated except wheeling the coal. I tell of these things to show conditions as I have found them in states where there are no standards of efficiency for engineers, and the same conditions exist in that plant today and in many others of which I know.

I held that job a couple of years and then worked along to a bigger plant, and so on until I became chief in a good-sized plant. I have held some fairly good positions in that capacity, but I was always more or less dissatisfied, owing to the fact that anyone who chose to call himself an engineer could be one, and if I tried to get the pay I deserved I was usually told that, while my work was satisfactory, there was someone who would take the job as it was. As a lot of plant owners never realize the difference between one engineer and another, there isn't much chance for an argument in such a case, and about all there is to do is move along.

I finally decided to go to Massachusetts and see if conditions were not better there. Upon finding a good location, I put in an application for a license, but I didn't get a first and found that I was lucky to get a second, for while I thought I had been studious and observing, there was really very little I knew well enough to be sure of, and no apologies are accepted by the board of examiners.

I am glad that I came to a license state, for I found how little I knew compared with what I had supposed I did. I also discovered that the time I had spent working in states where there were no license laws was about half wasted. The real trouble in my case before coming here was the same as in a lot of similar ones—there was no real incentive for me to get right down to the very bottom of things and find why they were thus and so, and I had therefore neglected to do so. When I went up before a board composed of men who knew their business I was simply stuck and was ashamed that I had claimed to know enough to apply for a license.

The only ones who are opposed to the license laws in this state are those who haven't been able to get a license as big as they think they ought to have, and also a certain class of plant owners who are afraid that the time is coming when they will have to pay power-plant operatives what they are worth.

It is the engineers' own fault to a great etxent, for had they stuck together as they should have done and helped one another to get a better education by belonging to an association founded upon the right principles, there would be a different state of affairs in the engineers' world today and every state would have a license law and the country would not be overrun with those who will work for what is offered them for the sake of being called engineers.

Unionism will bring about the desired conditions, but not the kind of unionism that most people think is going to do it, for there is not enough of the educational idea written into the constitutions of the labor organizations in this country, and there is not enough Americanism either, but there is a tendency for inefficient men to flock into the unions and lean on those who are efficient.

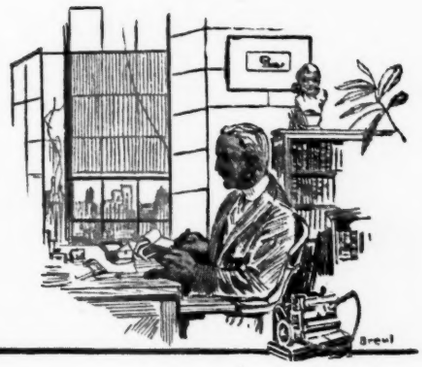
I am a member of the N. A. S. E and am a firm believer in the principles of the organization, and it is due to the efforts of that organization that we have an engineers' license law in this state. I believe that if every power-plant operative would join we would accomplish more for the benefit of our trade in a few years, by education and legislation, than has been accomplished by any means in the past. There is nothing in the constitution of the association that prevents a member from belonging to a labor union or that prevents a union man from joining the association, so there is no reason why they should not get together and work as a unit for the betterment of all concerned.

There are those who may be opposed to an engineers' license law because they doubt their ability to secure a license, but a provision could be made the same as that which was made in this state when the license law was passed, which allowed a man who had for a certain length of time successfully operated a plant that was rated as first-class to receive a first-class license, and so on down to the firemen. While this law did not have all the desired effect at once, it kept outsiders away and soon began to raise the plane of education among engineers and firemen, and at the present time the laws are much more rigid and a man has to pass a better examination to get a license now than at hat time.

Let us as engineers and firemen work toward the enactment of a National engineers' license law, which will be the greatest step we could take toward better educated men of our trade, which will raise our standing and lead to better wages and conditions.

Webster, Mass. LLEWELYN M. REED.

INQUIRIES OF GENERAL INTEREST



Height of Settings for Return-Tubular Boilers—How high above the grates should two 72-in. x 18-ft. return-tubular boilers be set to secure the best combustion? E. G.

The most perfect combustion would be attained with the boiler set so high above the grates that they would absorb no heat from the fires during the process of combustion. But with an ordinary return-tubular boiler setting, the greater the height the greater the loss of heat from the side walls and less benefit from absorption of heat by direct radiation from the fire to the under side of the shell. For average fuel and hand-firing, the best over-all fuel economy usually is obtained for 72-in. boilers when set 30 to 36 in. above the grates.

Setting Piston Clearance of Compressor—In which end of the cylinder of an ammonia compressor should the piston rod be set to give greater amount of piston clearance? M. J. M.

The end of the cylinder that should have the piston set with a greater amount of piston clearance depends on the design of the connecting-rod. If taking up the connecting-rod brasses tends to lengthen the rod, the piston should be set in the crosshead so there will be a greater piston clearance in the head end of the cylinder; and if taking up tends to shorten the connecting-rod, the piston should be set with greater piston clearance in the crank end of the cylinder.

Lame Running of Duplex Pump—What causes a duplex pump to run lame, and how can the fault be remedied? W. L. G.

If, after the valves have been set, the pump runs "lame," showing an inequality in the length or time of the strokes, it may be because the resistances of the water cylinders are different. They should be examined for leaky water valves, and tight packing of pistons and stuffing-boxes. If the pump continues to run lame after such faults have been corrected, the lost motion of the valves must be readjusted for obtaining the desired equality of strokes, bearing in mind that reducing the lost motion obtains more throw of the valve and provides wider steam and exhaust openings.

Velocity Acquired by Drop of Elevator Cage—If an elevator cage weighing 4,000 lb. should drop 150 ft., at what speed in feet per second would it be traveling and how long would it take to fall? J. A. C.

The velocity of a body freely falling in vacuo and the time required to fall are independent of the weight of the body. The velocity freely falling in vacuo is given by the formula $v = \sqrt{2gh}$, where v = the velocity acquired in feet per second; g = the acceleration of gravity, usually taken as 32.2, and in freely falling in vacuo from a height of 150 ft. the velocity would be

$$v = \sqrt{2 \times 32.2 \times 150} = 98.3 \text{ ft. per sec.}$$

If t = the number of seconds in falling, then the time occupied falling freely in vacuo is given by the formula

$$t = \sqrt{\frac{h}{\frac{1}{2}g}}, \text{ or when } h = 150 \text{ ft., the time would be}$$

$$t = \sqrt{\frac{150}{16.1}} = 3 \text{ sec.}$$

The velocity acquired by an elevator cage dropping would be less and the time required would be greater than falling in vacuo, depending on the frictional resistance of the guides and resistance of the air.

Testing Quality of Steam with Separating Calorimeter—For determining the quality of steam with a separating calorimeter, the graduated glass gage showed that the amount of water collected was 0.21 lb., and during the same time there was 2 lb. 3 oz. of condensate added to the condensing water What was the quality of the steam? A. N. F.

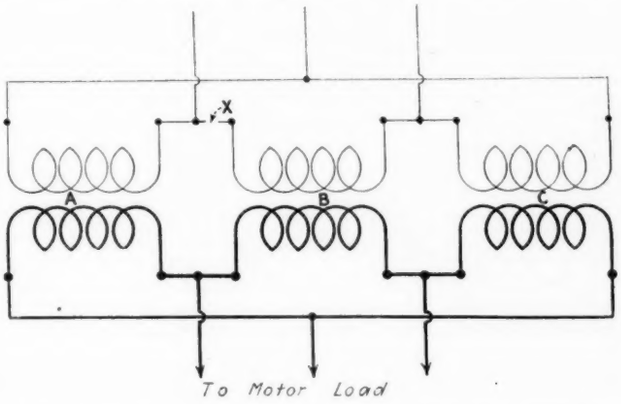
Where W represents the weight of water that the calorimeter separates from the steam, and W_1 represents the weight of dry steam condensed after separation, then the total weight of steam tested would be $W + W_1$, and the quality q, or dryness, would be given by the formula

$$q = \frac{W_1}{W + W_1}$$

In the example, $W_1 = 2$ lb. 3 oz., or $2\frac{3}{16}$ lb. $= 2.1875$ lb., and $W = 0.21$ lb., and by substitution the quality is found to be

$$q = \frac{2.1875}{0.21 + 2.1875} = 0.912, \textit{ or about } 91 \textit{ per cent.}$$

Open Connection in Transformer Bank—Three single-phase transformers are connected delta as in the figure and are supplying a load of three-phase induction motors. If one



of the connections between the transformers became open as at X, what effect would it have on the operation of the motors? E. M. W.

With an open-circuit at X transformer B will be cut out of circuit and transformers A and C will be connected in open delta. Transformers A and C will then be capable of supplying only 58 per cent. of the normal capacity of the three transformers; that is, if the bank of three units has a capacity of 100 kv.-a., two of them connected open delta will only have a capacity of 58 kv.-a. As far as the operation of the motors is concerned, it will be about the same with the open-delta connection as with the closed-delta. However, if the three transformers were operating near full load before the open occurred, then the two transformers operating open delta will be overloaded and it will be necessary to shut some of the motors down to relieve the overload until the defect is repaired.

Excerpts From Elevator Safety Orders State of California

By EDWARD A. SMITH

Mechanical Engineer, Otis Elevator Co., New York, N. Y.

EXCERPTS from elevator laws of the State of California for power-driven passenger, freight and sidewalk elevators, effective Oct. 1, 1916; revised Apr. 1, 1918. For all elevators in the state except private houses and United States Government buildings. The excerpts are from the laws pertaining to both existing and future installations. Where the law is for future installations only, it is not quoted except where noted.

Load: Passenger—Passenger capacity limited to 2½ sq.ft. per person, provided this does not exceed load capacity.

Speed: Passenger—Not to exceed 600 ft. per min., except express elevators running 80 ft. or more without a stop, may run 800 ft. per min. (First stop 80 ft. and local above). Freight—Same as passenger, except without a regular operator limited to 100 ft. per min., but does not apply to operatorless, push-button or outside switch control.

Safeties and Governors: Passenger—Over 150 ft. per min. gradual-operating type safety with speed governor at top of hatchway to trip at 40 per cent above normal up to and including 550 ft. per min; above 550 ft. per min. trip 30 per cent above normal. Speed to be stamped on governor; 150 ft. per min. or under, instantaneous, or roll safeties with governor. Future governor to be equipped with device for cutting off current for electric machines 300 ft. per min. or over. No safety required on existing elevators rise 12 ft. or less. Instantaneous broken-rope safeties to be provided on counterweight located over passageway or vault. All future safeties to be under platform and between safety plank. Safety drums to have twice as much rope as required to operate. Governor ropes to have tension frames. Safe-lift elevators to have locking device. No safeties permitted on plunger elevators. Freight—Same as passenger except broken-rope safeties allowed for 15 ft. rise or less.

Car enclosures and platforms and slings: Passenger—Grille covered with ¾-in. wire mesh, No. 16 gage on outside. Enclosure to be bolted or screwed to car floors also bolted to sling. Existing grille tops to be made solid or covered with ½-in. screen No. 18 gage. Two openings in car maximum number allowed, with gate farthest from operator under operator's control (hydraulic elevator). For electric elevators gate contact or other equal device required; no gate is required for single opening car except push-button. No vertical compartments permitted, but two horizontal permitted with access to hatch through one only. Over-all dimension of vertical guide shoes to be not less than one-half largest car dimension except plunger elevators. No mirrors or glass permitted in car construction, except for covers for annunciators, lamps or over certificates and 36 sq.in. maximum mirror for operators. Cars to be lighted. Threshold light recommended but not required. Push-button elevator gates at all openings with contacts on future gates 3 in. maximum between vertical bars; alternate bars to act as guides. Future clearance between car and sill or gate, or door, minimum ¾ in., maximum 1½ in., minimum between any other part 1½ in. If impractical to maintain 1½ in. maximum, semiautomatic gates must be furnished on landing or gate on car with contact. Freight—Wood or metal 6 ft. high on unused sides, solid or open 2-in. mesh. None required on uncounterbalanced plunger cars rise one floor. Opening in side of car enclosure permitted for hand rope. No gates required. Tops of cars to be wire 1-in. mesh No. 12 gage or other construction of equal strength. Cut back not more than 6 in. from sill at entrance and hinged not less than 18 in. Car tops not required for following conditions: (1) Where trap doors are used: (2) where semiautomatic gates extend to floor, except at lowest floor; (3) where hatchway doors are provided opening from shaft side only and are kept closed; (4) uncounterbalanced plunger elevator; (5) elevators whose platforms exceed 96 sq.ft., except that hinged screens must be provided 4 ft. back and extend across entrance. No mirrors or glass permitted except for covers for annunciator, lights or certificates and a 36-sq.in. mirror for operator. No vertical compartment permitted, but two horizontal compartments permitted with access to hatch through one only. Car to be lighted. Over-all dimension of vertical guide shoes to be not less than one-half largest car dimension, except plunger elevator. Minimum clearance ¾ in. between sill and car, or gate, or door, 1½ in. maximum. Minimum between any other parts, 1½ in. If impractical to maintain 1½ in. maximum, semiautomatic gates must be furnished on landing or gate on platform with contact. Sidewalk—No enclosure required. No light required. Bow irons required or some automatic means of stopping car in case sidewalk doors refuse to open.

Control: Passenger and Freight—Centering device required where hand rope is on opposite sides of hatchway. Electric car switches to be self-centering. Push-button must have emergency stop, also switch control. Car switches or levers made to operate alike where two or more elevators are installed. Sidewalk—Centering ropes not required on hand ropes, otherwise same as passenger and freight.

Hatchway gates: Passenger—Not permitted. Freight and sidewalk—Gates or doors to be furnished at all hatch openings. Semiautomatic wood or metal gate to stand 250 lb. at any point without springing or binding, 5 ft. 6 in. high, 6 in. underclearance, 3-in. space between vertical members or wire mesh. Where future hand-rope operation an opening 3 ft. long and 5 in. wide to be provided in 5-ft. 6-in. gates only. Gates 3 ft. 6 in. high permitted, if above impractical due to bad conditions, at discretion of commissioner, provided telltale chains or ropes 4 ft. long and 5 in. apart on platform are furnished. Gates to begin to close before car moves one foot. Double-blade gates permitted only if solid panels are furnished or panels are covered with fine wire mesh. Full-automatic gates permitted at terminal landings only and 5 ft. 6 in. high. Manually operated gates to have contacts. Horizontal folding gate not permitted except at discretion of commissioner. Gate counterweight to be boxed in or run in guides to be closed at bottom to prevent counterweight from falling.

Ropes: Passenger—Iron or steel permitted. Steel ropes to be labeled, "Use steel cables only" on metal plate on crosshead and top counterweight. Metal tags on all ropes giving date of installation, at crosshead and counterweight. Factor of safety, 8 manufacturer's list. Future minimum size, ½ in. Future drum machines, 2 ropes to a car and each counterweight 1½ turns on drum. Future traction machines require 4 ropes; 2 ropes on progressive-groove traction machines. Future hydraulic machines, 4 ropes and 2 counterweights. No splicing of hoist or counterweight cables. Governor ropes must be iron or steel ½ in. minimum diameter over 150 ft. per min. car speed. Manilla or hemp, 150 ft. per min. or under, ⅝ in. minimum diameter. Ropes to drum must be clamped or have tampered sockets inside drum. Ropes in socket may be fastened by "turned in method," "turned out method" or "straight method." Hand ropes to be metal tiller ½ in. diameter, with electro-mechanical brake ⅜ in. permitted. Counterweight ropes passing through an upper counterweight to be protected from injury. Freight—Same as passenger except factor of safety of 6 permitted. Future traction freight elevators not limited to four ropes if speed is 150 ft. per min. or under. Future hydraulic freight elevators, 2 hoisting and 2 counterweight ropes. Sidewalk—Same as freight except not limited to minimum size of ½ in. Chains not permitted.

Equalizers: Passenger and Freight—Must be used on car and counterweight where overhead drum machines are used, when grooved right and left hand.

Grating: Passenger and Freight—Substantial grating 2-in. mesh or bars 2-in. centers with wire screen No. 20 gage, ½-in.

mesh, of metal, or a flooring to sustain a load of 300 lb. at any point, except where trapdoors are used. Cover entire hatch if 50 sq.ft. or less, otherwise 2 ft. outside of all sheaves and machinery with baseboard 6 in. high, and suitable handrail if space between grating and wall exceeds 12 inches.

Counterweight Screens: Passenger and Freight—Bottom screen 7 ft. high, fireproof material in fireproof shaft; if mesh ¾ in. by No. 20 gage, not required with counterweight chains or cables. If counterweight is adjacent to door opening, screen to extend 7 ft. above lowest floor. No screen required for push-button elevator in single shaft or elevators with contacts on basement doors. Sidewalk—Same as passenger if counterweights are used.

Stop Motions and Shaft Limits: Passenger and Freight—Machine limits required on drum machines. Passenger electric machines (existing and future) to have electric shaft limits and future freights. Hand ropes to have stop balls to stop machines at top and bottom. Hydraulic elevators to have stop balls on hand ropes to stop machines at top and bottom. Sidewalk—Machine limits on drum machines and stop balls on hand rope or chain.

Interlocks: Passenger—Standard No. 3 lock or Wells-VanAlstyne or equally good for horizontal sliding doors to be used on all push-button operations. All future electric passenger elevators to have contacts on doors or other suitable interlocks with emergency releases in car under glass within easy reach of operator. Future safe lifts to have locking device. Freight and Sidewalk—Interlocks required on manually operated doors or electric contacts. Doors arranged to open outside of hatch by means of key only, where there is a regular operator, permitted provided doors have contacts or equivalent devices.

Emergency Switches: Passenger and Freight—Where interlocks are used (see interlocks), all future power-driven switch-controlled and push-button-controlled elevators to have emergency switch or button in car to cut off current independently with potential switches. Proper fuses or circuit-breakers to be furnished. Breaking or holding-open safety circuit not to depend on springs only. Existing and future passenger and power freight elevators (except with existing trapdoors and then gong to be furnished) to have signal system except push-button and serving two continuous floors only. Slack-cable device, covered and insulated, furnished on all drum machines.

Brakes: Passenger—Electric brakes required on all passenger elevators. Mechanical brakes not permitted. Freight and Sidewalk—Mechanical brakes permitted only on existing freight elevators speed 75 ft. per min. or under.

Rope Locks: Passenger and Freight—To be furnished on car for all hand-rope operations.

Hatchway Enclosure: Passenger—(See local laws for enclosures.) Enclosed on all sides at least 6 ft. high and full height on counterweight portion. Counterweight enclosure may be solid or open ¾-in. mesh. All unguarded sides inside of hatchway to be flush. All other sides flush or all projections beveled at angle of 60 deg. with horizontal. This applies to future and existing elevators, since Oct. 1, 1916, or other cases considered unsafe by accident commission. Safe access must be provided in penthouse and lighted. Freight—Same as passenger except enclosure only on unused sides 6 ft. high and over counterweight to run to ceiling solid or ¾-in. mesh. Sidewalk—Enclosure on unused sides 6 ft. high. Future openings in sidewalk not to exceed 5 ft. at right angles to, or 7 ft. parallel to, curb.

Hatchway Doors: Passenger—Doors must be furnished at all openings in accordance with fire ordinances in locality of installation. Minimum requirements wood or metal solid 3 ft. high with grille above 2-in. mesh or vertical bars 2-in. centers. Doors to be hatched on shaft side and lock to be inaccessible from outside except with a key, push-button elevators excepted. Latch of door, when open, to be free and accessible to operator. Floor space in front of door openings on future installations to have non-slip surfaces 20 in. wide. Doors should not be opened or closed unless car is stationary at landing. Freight—Semiautomatic doors or gates to be furnished at all entrances. Manually operated doors permitted if provided with interlocking device. Doors arranged to be opened from outside with a key must have contacts or equivalent and a regular operator. Future Peelle type doors must have contacts. Sidewalk—Same as freight. When sidewalk doors are open, must have screen or gate from top of door to sidewalk. Attendant must be posted at sidewalk before opening doors.

Motor-room enclosure: Passenger, freight and sidewalk—For penthouse, see paragraph on hatchway enclosures. Future machine-room enclosure of size to give free and safe access to all machinery. Existing and future must be lighted, machinery to be guarded according to general safety orders, electric machines to be grounded.

Operator: No regulation.

Hydraulic Tanks, Valves, Cylinders and Parts: Valve chambers to have means of removing air. Must have air-siphon relief valve on discharge pipe. Future vertical traveling-sheave straps to be made of two structural shapes, no "U" straps permitted. Existing and future pressure tanks designed so that air will not pass to cylinder. Reciprocating pump to be equipped with water safety valve only between pump and pressure tank to prevent increase of pressure more than 25 per cent when pump is at full speed. Valve to be piped to discharge tank above water line. Existing installations may be discharged into pump suction. Existing and future steam pumps connected to air-pressure tanks must have steam-pressure regulators. Electric pumps must have automatic pressure regulator controlling motor or with automatic bypasses. Pumps to accumulators other than regulating type not containing air to have automatic shutoff valves or bypasses. Installations prohibited: Belt or chain-driven machines prohibited on new installations. Power-driving mechanism applied to hand power. Friction-gear or clutch mechanism between drum or traction sheave and main driving gear. Worm gear cut into cast-iron rim not permitted, except dumbwaiter and for freight and sidewalk of 2,000-lb. capacity or under and 75 ft. per min. or under. Cast-iron guide rails prohibited. Two elevator cars, balancing each other and operated by the same machine, except for dumbwaiters having terminal landings only. Cast iron not permitted for safeties except drum. Gripping portions of safety device not to be used as guides to car. The use of control systems depending on electric batteries for interruption of operating circuit. Future mechanically controlled elevators (except dumbwaiters) opening of direction switches or operating valves not to depend solely on sprockets or chains. Existing and future machine and car counterweights not independent and separated prohibited.

Repairs and alterations: Changes other than ordinary repairs are considered new installations and must conform to above orders. An existing elevator moved to new location is a new installation.

Tests: Load test for every new elevator. Existing and future—Every car safety to have drop test before accepted by commissioner. New installations to have drop tests in presence of authorized representative of industrial accident commission. Safety devices to have actual running test at full load.

Fifteen Firms Unite in Plant Display at Machinery Center

Service to the prospective buyer of construction plants was made available in a new and progressive form when the Allied Machinery Center, comprising a permanent exhibit of the products of fifteen noncompeting manufacturers, was formally opened by the Allied Machinery Company of America in New York City. The new center, occupying 30,000 sq.ft. of exhibition and office space at Center and Walker streets, New York, is the first of its kind to be established as part of an educational and sales-promotion plan in the field of heavy construction plants. It is comparable, in a way, to the department-store idea of merchandising drygoods by assembling a variety of products in one building so that the buyer may supply his needs without the inconvenience of journeying to half a dozen stores.

But the idea behind the machinery-center project is a broader one than merely making it easy for the machinery buyer to do his shopping. A fundamental aim of the enterprise is the education of the user in sound construction economics—in using the right machine and particularly, where the size of the job warrants, the right combination of equipment for doing the work with the maximum of economy and speed. This feature of the plan, it is pointed out, has a special signifi-

cance at present when the cost of common labor has soared to heights not dreamed of half a dozen years ago.

The machinery center is designed to serve the needs both of the export buyer and the domestic purchaser. With respect to the former the great need abroad is generally conceded to be an appreciation of the results obtainable by American construction methods, which means, of course, the substitution where practicable of machinery for hand labor. This lesson is still to be learned, a fact not fully appreciated by anyone who has not actually been on foreign soil and studied conditions at first hand.

The following firms are represented at the Machinery Center: Austin Manufacturing Co.; Austin-Western Road Machinery Co.; Barber-Greene Co.; Carbic Manufacturing Co.; C. H. & E. Manufacturing Co., Inc.; Clyde Iron Works; Cook Motor Co.; A. B. Farquhar Co., Ltd.; Hydraulic Pressed Steel Co.; Lakewood Engineering Co.; Parsons Co.; Sterling Wheelbarrow Co.; Thew Automatic Shovel Co.; Western Wheeler Scraper Co.; Wyoming Shovel Works.

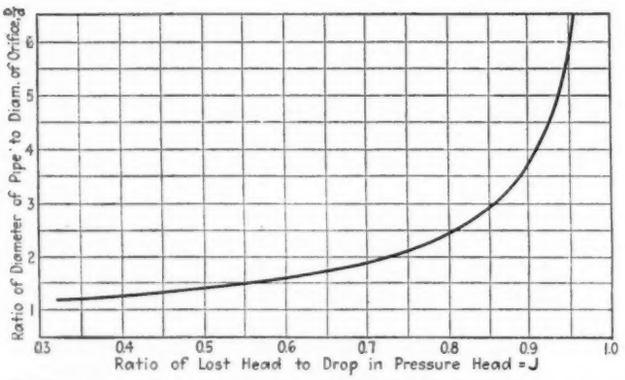
At a luncheon given Jan. 27 to celebrate the opening of the Allied Machinery Center the speakers included Joshua W. Alexander, Secretary of Commerce; Senator Edge, W. L. Saunders, George Edward Smith and former Secretary of Commerce W. C. Redfield.

Measuring Flow of Water by Orifice*

By Raymond E. Davis and Harvey H. Jordan

A thin plate orifice inserted in a pipe line is looked upon as a temporary or field device for measuring the flow of water, being simple to construct and easy to install. In flanged pipe systems such an orifice may be inserted with little or no disturbance of existing piping, and in long pipe lines the loss in head caused by the orifice will be inconsiderable as compared with other losses.

An orifice causes an abrupt change in conditions of flow, and this change is accompanied by a drop in pressure head



COEFFICIENTS FOR FINDING LOST HEAD DUE TO ORIFICE IN WATER PIPE

which may be easily measured and which varies with the velocity of flow in the pipe. The experiments herein described were made to determine (1) the positions of two cross-sections of the pipe where the drop in pressure head may be most favorably determined, (2) the relations between this drop in pressure head and the rate of discharge through the pipe, (3) the lost head caused by the orifice, (4) the effect of small deviations from what may be called standard conditions, and (5) the proper size of orifice for given conditions.

This method of measuring flow of water in pipes is by no means new, but the authors have aimed to use methods that are applicable to ordinary practice rather than to refined laboratory practice.

The principal tests were made on 4-in., 6-in. and 12-in. commercial steel pipe which had been in use for some years, so that, owing to roughness and other variations, the error of measuring diameters was perhaps 0.02 in. Eight orifices were used with each pipe ranging from one-eighth to five-sixths of the pipe diameter and the eight ratios of pipe diameter to orifice diameter for the 4-in. series were approximately the same as for the 6-in. and 12-in. series.

To determine the proper cross-sections of the pipe at which to take pressure readings, gage connections were made at a number of positions upstream and downstream from the orifice. A study of a large number of observations leads to the conclusion that for flow measurement, gage readings should be taken with connections at the section of the beginning of convergence of the stream and at the section of greatest contraction of the jet. These points were determined to be at eight-tenths of the pipe diameter upstream from the orifice and at four-tenths of the pipe diameter downstream from the orifice respectively. It was also shown that normal flow was again resumed at a distance of three or four pipe diameters downstream from the orifice.

Since the determination of the rate of flow is made from the drop in head between the points eight-tenths pipe diameters upstream, and four-tenths diameters downstream from the orifice, a wide range of tests was made to determine the relations between these values. The theoretical equation for the quantity of water discharged may be written as follows:

$$Q = A \sqrt{\frac{2\,g\,h}{\left[\frac{D}{d}\right]^4 \frac{1}{C^2} - 1}}$$

where Q = the discharge in cubic feet per second, A = the area of the pipe in square feet, $g = 32.16$, h = the drop in pressure head in feet of water, D = the diameter of the pipe in inches, d = the diameter of the orifice in inches, and C = the coefficient of discharge.

This equation may be written in the form

$$Q = A K \sqrt{h} \text{ where } K = \sqrt{\frac{2g}{\left[\frac{D}{d}\right]^4 \frac{1}{C^2} - 1}}$$

The value of K to which the authors give the name, "velocity modulus," is seen to depend on the ratio of pipe to orifice diameters and on the coefficient of discharge C.

From the results of these tests the values of K are given in Table I for a number of cases. These values of K are based on value of C for a pressure drop of one foot. Now

TABLE I. VELOCITY MODULUS—K

$\frac{D}{d}$	Velocity Modulus					
	4-In. Pipe	5-In. Pipe	6-In. Pipe	8-In Pipe	10-In. Pipe	12-In. Pipe
2.00	1.275	1.250	1.240	1.240	1.240	1.240
2.10	1.150	1.123	1.111	1.110	1.110	1.110
2.20	1.030	1.015	1.010	1.010	1.010	1.010
2.30	0.944	0.930	0.925	0.925	0.925	0.925
2.40	0.865	0.850	0.845	0.845	0.845	0.845
2.50	0.798	0.785	0.779	0.779	0.779	0.779
2.60	0.736	0.725	0.720	0.720	0.720	0.720
2.70	0.684	0.672	0.667	0.667	0.667	0.667
2.80	0.635	0.625	0.620	0.620	0.620	0.620
2.90	0.592	0.583	0.578	0.577	0.576	0.576
3.00	0.553	0.545	0.540	0.540	0.539	0.539
3.25	0.473	0.465	0.462	0.461	0.461	0.461
3.50	0.405	0.399	0.395	0.395	0.395	0.395
3.75	0.351	0.345	0.342	0.342	0.342	0.342
4.00	0.310	0.305	0.303	0.302	0.302	0.302
4.50	0.244	0.240	0.238	0.237	0.237	0.237
5.00	0.197	0.194	0.192	0.192	0.192	0.192
5.50	0.165	0.161	0.160	0.160	0.160	0.160
6.00	0.138	0.136	0.135	0.135	0.135	0.135

since C was found to decrease slightly as h increases, the values of K are too large for a large drop in head and slightly too small for a small drop in head. However, the practical limits for h seem to be between 0.1 ft. and 10 ft., and between these limits the errors introduced by the use of this table are negligible.

Another equation, based upon the observations made, is suggested, namely:

$$V = 4.85 \frac{h}{\left[\frac{D}{d}\right]^2 - \left[\frac{d}{D}\right]^4}$$

where V is the velocity in the pipe in feet per second and the other letters have the same meaning as in the former equation. This equation has the advantage that the variable coefficient of discharge is eliminated and will give practically the same

*Abstract from Bulletin No. 109, Engineering Equipment Station, University of Illinois.

results as the other equation when values of $\frac{D}{d}$ are between 2 and 6.

The loss of head due to the orifice is the difference between the pressure head where the flow is normal upstream from the orifice and that where normal flow is again resumed below the orifice. The theoretical equation for the relation between this lost head and the drop in pressure at the orifice is too complicated for general use but the authors have suggested the simple form

$$h_a = J\,h$$

where h_a is the loss in head, J is a coefficient depending on the ratio of diameters, and h is the drop in head at the orifice. Values of J may be obtained from the accompanying curve.

The choice of the size of orifice to be used may depend upon four factors: The rate of flow in the pipe, the lost head that may be allowed, the desired precision of discharge measurement, and the maximum drop in pressure head the differential gage will register. In general it is best to use an orifice not larger than half the pipe diameter, or in other words, $\frac{D}{d}$ not less than 2.

Table II shows approximate values of drop in pressure head and lost head for several velocities and values of $\frac{D}{d}$.

As an example let it be required to measure the rate of discharge through an 8-in. pipe in which the velocity may vary

TABLE II. APPROXIMATE VALUES OF DROP IN PRESSURE AND LOST HEAD

h = drop in pressure head in feet; h_a = lost head in feet.

V	$\frac{D}{d}=1.2$		$\frac{D}{d}=1.5$		$\frac{D}{d}=2.0$		$\frac{D}{d}=2.5$		$\frac{D}{d}=3.0$		$\frac{D}{d}=4.0$	
	h	h_a	h	h_a	h	h_a	h	h_a	h	h_a	h	h_a
0.2	....	....	.....	.....	.....	.....	.....	.....	.....	.....	0.43	0.39
0.5	....	....	.....	.....	0.16	0.12	0.41	0.33	0.86	0.73	2.7	2.5
1	....	....	0.17	0.09	0.64	0.46	1.6	1.3	3.4	2.9	10.8	9.8
2	....	....	0.66	0.36	2.6	1.9	6.5	5.3	14	12	43	39
3	0.37	0.12	1.5	0.8	5.8	4.2	15	12	31	26	.....	.....
4	0.65	0.21	2.6	1.4	10	7	26	21	55	47	.....	.....
5	1.0	0.3	4.1	2.3	16	12	41	33	.....	.....	.....	.....
6	1.5	0.5	5.9	3.2	23	17	59	48	.....	.....	.....	.....
10	4.1	1.3	17	9	64	46	.....	.....	.....	.....	.....	.....

from one to six feet per second. What size orifice should be used? From Table II, with a diameter ratio $\frac{D}{d} = 2$, the lost head is 0.46 ft. and the drop in pressure head 0.64 ft. for a velocity of 1 ft. per sec., while they are 17 ft. and 23 ft. respectively for a velocity of 6 ft. per sec. An orifice with a diameter ratio $\frac{D}{d} = 1.5$ gives a range of lost head from 0.09 to 3.2 ft. and of drop in pressure head from 0.17 to 5.9 ft. The first orifice gives a rather high lost head and pressure drop at high velocities, while the second one gives rather low values at low velocities and will not be so accurate. Probably an orifice giving $\frac{D}{d} = 1.6$ or 1.75 would be advisable.

In using orifices for measuring flow of water in connection with the data given here, precautions should be taken to limit the avoidable errors. The edges of the orifices should be sharp and square. While these experiments were made with orifice plates $\frac{1}{8}$ in. thick, the authors think no error would be made in using thinner plates. The pipe should be straight and uniform for ten pipe diameters or more above the orifice. Gage connections should be not smaller than ¼-in. pipe, and care should be taken to remove all burrs from the pipe and that the nipples should not protrude beyond the inner surface of the pipe.

When $\frac{D}{d}$ is equal to or greater than two, a single nipple at each section will be sufficient and the exact location of the section may be varied slightly from the positions specified. When $\frac{D}{d}$ is less than two, however, two nipples should be used and no variation in their location should be allowed. Provision should be made for removing air from the pipe and gage connections. If proper precautions are taken, the authors claim that the rate of discharge as measured by a pipe orifice should be accurate within 2 per cent.

Throttling the gage connections was found to help only in the case of large orifices and had to be done very carefully. Small eccentricity in the location of the orifice had no effect on smaller orifices and could be taken care of by using two gage connections when using the larger orifices. The coefficient of discharge for bevel-edged orifices is much more variable than for square-edged orifices, and the use of bevel-edges is not recommended. In general, orifices larger than two-thirds of the pipe diameter should not be used except for very rough measurements.

Western Society Foresees Great Developments

On Jan. 28 the Western Society of Engineers held its annual dinner at Hotel Morrison, Chicago. About 350 were in attendance, and under the direction of Frederick P. Vose, a very capable toastmaster, the event was a great success. An orchestra, community singing, the Universal Glee Club and Quartette added zest to the meeting and kept the enthusiasm at the proper pitch to enjoy the many good things on the program.

Major General Leonard Wood spoke briefly, referring to the constructive engineer and the sanitarian as the principal aids of colonial administration. He reviewed the work they had done in the Philippines, at the Panama Canal and in Cuba. In the territory last named, an independent department of public works had been formed under his administration, and it did all work under a fixed budget. It was the speaker's opinion that a similar plan would be a good thing in this country. In the world war the engineer went hand in hand with the sanitarian and the doctor, each making an enviable record in his particular sphere. The general was especially interested in the building up and keeping alive of the Engineers Reserve Corps, so that such an important branch of the service would be ready when trouble came, and in times of peace the various units could prepare plans of defense for their respective cities and have all in readiness for construction when the occasion arose. A defensive alliance with the architects was desirable. There should be harmony between the two professions, and the combination should take an active part in public affairs, guiding and keeping constructive civic building and preventing the monstrosities that creep in when industrial interests are allowed free reign.

A. Stuart Baldwin, retiring president, delivered a most eloquent and inspiring address, dealing in particular with the broadening field of the engineer and his great work of the future in bringing about coöperation and coördination between the two extremes representd by capital and labor. It was his opinion that there would soon be a marked development of the power of the great middle class in exercising control over the relatively small groups of capital and labor. If either of the latter factions ruled implicitly, then civilization would fail. There must be liberty, equality and fraternity, with the Golden Rule as the guiding spirit. Lack of mutual consideration had been the chief cause of the growing antagonism and unrest. Good will was the most potent and practical force at the disposal of the engineer, and it is a force of which the world is in desperate need. Its recognition and acceptance would lead to development beyond any present conception.

During the year the society had trebled its membership and had obtained an excellent representation from the large body of engineers in the great industrial center about Chicago. Organization of the new members was the first duty, with an engineering building in the background. With so large and so diversified a membership including all kinds of engineers, in his opinion the work of the directors must be decentralized and assumed more by the chairmen of the various sections, each section becoming to a certain extent a self-contained society, but all coöperating as a part of the main body. If each section were the local branch and representative of the national society with which most of its members are affiliated, and if each national society would be the willing associate of the section, such a plan would strengthen both the sections of the Western Society of Engineers and the national associations, the latter having need of greater local activities, which they would gain through the support of the sections.

In his inaugural address F. K. Copeland, president-elect, touched upon future lines of activity for the society. In the

past the society had stuck too closely to technical matters. The recent growth indicated that it had a place to fill. In civic affairs the society should take a part equally important as the Chamber of Commerce. There were questions of city planning and zoning, railway terminals, etc., in which the engineer would be of the greatest value. To promote social development the speaker urged the advantages of wider acquaintanceship through meetings, excursions, noonday luncheons and in particular urged the engineers to be more sociable among themselves at these gatherings. The younger men may not think that they can spare the time, but it was to the advantage of the employer to encourage them to make use of these opportunities of mixing with the older men of wider experience. Each man must think what he can do to improve and take his full quota of the advantages offered by the society. The many new members must be made to feel that their joining has been the most worthwhile thing they have done for years. The officers cannot do all. It is their plan to set each and every member to work. If every man will take part and carry on, the society has before it a most successful year.

Announcement was made of the following incoming officers: President, F. K. Copeland; first vice president, C. F. W. Felt; second vice president, J. L. Hecht; third vice president, Linn White; treasurer, F. F. Fowle; secretary, Edgar Nethercut; trustee for three years, J. H. Libberton; Washington Award Commission for three years, Albert Reichman and Major E. W. Allen. Chairmen of the various sections are: Hydraulic and municipal, William Artingstall; mechanical, Arthur L. Rice; bridge and structural, A. W. Dilling; electrical, A. F. Riggs; gas, C. C. Borden. Chairmen have yet to be elected for the three new sections; telegraph and telephone, industrial and railway.

Marine Engineers Hold Annual Meeting

The Marine Engineers Beneficial Association held its forty-fifth annual convention at Washington, D. C., during the week beginning Jan. 19, with headquarters at the New Ebbitt Hotel.

There were present 160 delegates, representing 231 votes. The opening session took place at ten o'clock on Monday morning, with every officer at his proper station. The large volume of business transacted made it necessary to hold night sessions, and during the week many important measures tending to the uplift of the organization were discussed and voted upon. The report of Albert L. Jones, the treasurer, showed that the association is on a sound financial basis. During the past year it was decided by a referendum vote to combine the offices of secretary and treasurer.

At the meeting on Monday morning the delegates were addressed by Darragh de Lancey, Director of Docks and Industrial Relations of the United States Shipping Board.

On Tuesday morning the convention listened to an instructive and entertaining address by George Uhler, Supervising Inspector General of the United States Steamboat Inspection Service.

Notwithstanding the inclement weather which prevailed through the week, there were theater parties, shopping trips and sight-seeing auto drives for the ladies.

On Wednesday evening the ladies of the convention were entertained by A. Warren France, of the France Packing Co., in his suite at the New Ebbitt Hotel. Refreshments were served in abundance. The entertainers were George E. Andrews, Bob Jones and Jack Armour.

The big feature of entertainment was the smoker on Friday night tendered the delegates by the Marine Engineers Supplymen's Association in the ballroom of the New Willard Hotel. There were upward of 500 in attendance, including army and navy officers, heads of the various departments, and engineers from the local associations. Briarwood pipes, tobacco and cigarettes were distributed, and an excellent vaudeville show was furnished.

At the afternoon session of the convention on Tuesday the following officers were reëlected for the term of three years: William S. Brown, president, Buffalo; John S. Purdie, first vice president, San Francisco; William H. Hyman, second vice president, Baltimore; Edward C. Killian, third vice president, New Orleans; George A. Grubb, secretary-treasurer, Chicago. The National Executive Committee comprises: Robert Goalett, Atlantic Coast District; Charles Tollett, Pacific Coast District; William J. Garrett, Great Lakes District; Charles M. Sheplar, West Rivers District; Edward C. Killian, Gulf Coast District.

The Marine Engineers Supplymen's Association elected officers as follows: Andrew Lauterbach, president, the Lunkenheimer Co.; Charles A. Remsen, vice president, Dearborn Chemical Co.; Bob Jones, secretary-treasurer, France Packing Co.

At the final meeting of the supplymen, Joseph J. Cirek, the retiring president, was presented with a leather traveling bag.

Automotive Engineers Discuss the Diesel Engine

Diesel engines formed the topic for discussion at the joint meeting of the Pennsylvania and the Metropolitan (New York) Sections of the Society of Automotive Engineers at Philadelphia on Jan. 22. Leaving New York by special car in the morning, the Metropolitan members joined the Pennsylvania members at the Philadelphia Engineers' Club for luncheon, and were later conducted to the League Island Navy Yard to witness a run on one of a pair of Diesel engines recently removed from the German submarine U-117, which is there being tested out. After a supper at Kugler's in the

DELEGATES TO THE FORTY-FIFTH ANNUAL CONVENTION OF THE MARINE ENGINEERS' BENEFICIAL ASSOCIATION

evening, the members listened to an instructive paper on "Modern Practice in Heavy Oil Motor Installations, and Development Possibilities," by Hubert C. Verhey, head of the Diesel Engine Unit, Emergency Fleet Corporation. Many prominent Diesel-engine men were present, and a most profitable discussion followed.

The submarine U-117, it will be recalled, was the one which, early in 1918, operated off the Atlantic Coast. The engine tested is of the high-speed (450 r.p.m.) four-cycle Augsberg design, rated at 900 b.hp. in six cylinders, and presented some very interesting features. For instance, the housing and cylinder jackets are of cast steel with cast-iron cylinder liners. Owing to the scarcity of copper in Germany during the war, all the piping was made of iron and many of the connections welded. The compressor is a four-stage machine driven direct, and all auxiliaries likely to give trouble are in duplicate; there are also two fuel valves. Cross-connections were provided between the two engines, so that if certain auxiliaries on one failed, those on the other could be used while repairs were being made. The cylinder diameter is 17¾ in., and there was no taper on the skirt of the piston, as is very common practice. The stroke of 16¾ in. makes a low engine, which of course was necessary because of the limited headroom. Oil cooling is employed for the pistons through a link connection. It is not known how many miles this submarine had cruised in the hands of the Germans, but it has cruised over 10,000 miles since this country took it over; yet upon removing the pistons from one of the cylinders and calipering them, no perceptible wear was discovered. Moreover, the engine ran very quietly, with practically no vibration, as all of the nuts were found to have been put on with a driving fit. The workmanship throughout showed evidence of careful attention to every detail, which was characteristic of the Germans.

Diesel-Engine Discussion

Mr. Verhey, after following through, by the aid of slides and diagrams, the workings and complete installation of a marine Diesel engine outfit, proceeded to discuss the relative merits of different types and designs. He was of the opinion that although the four-cycle engine has largely displaced the two-cycle for marine purposes, ultimately the two-cycle design will predominate, because American engineers, profiting by the experience of European designers, are in a position to avoid the pitfalls of their predecessors and will overcome certain features that were responsible for troubles with the two-cycle design in the past. He pointed out the advantages of top scavenging for two-cycle engines, but showed that certain manufacturers were now bringing out designs embodying a double scavenging port, which would obviate the objections to the former method of port scavenging. He also referred to the advantages of the auxiliary exhaust.

Referring to fuel injection, he pointed out that it is possible to eliminate an air compressor entirely by injecting the fuel direct into the working cylinder under high pressure by the so-called solid injection system, which is now being employed by several builders; but with this system one is likely to get smoke and incomplete combustion, with resulting carbon when operating under light load. He favored very strongly independently driven auxiliaries, especially for marine purposes, for with this arrangement not only could there be employed greater duplication in auxiliaries, but the main engine would not be shut down if there should be trouble with any of the auxiliaries; and it permits continuing the circulating water for some time after shutting down the engine, a precaution that may save cracked cylinder heads.

Referring to the immediate field for the marine Diesel, he believed that it is limited at present to the propulsion of vessels up to 13,000 tons at from 10 to 12 knots, within which limit the motor installation will be able to hold its own under all circumstances. A vessel having about 1,500 hp., carrying 625 tons of fuel oil, can attain a cruising radius of about 20,000 miles with oil engines, as compared with 8,400 miles when equipped with steam-turbine installation, or 7,500 miles with a reciprocating steam installation. Passenger ships of greater tonnage and speed would not receive much competition from the Diesel engine, but would be equipped with geared-turbine installations for the time being.

Commenting upon the plans of the Emergency Fleet Corporation, Mr. Verhey stated that two 2,250-hp. four-cycle Burmeister & Wain engines have been ordered for a new 12,000 ton cargo boat that is now being built. In addition to this there has been installed a 750-hp. McIntosh & Seymour engine in one of the smaller boats, and another engine of 900 hp. is on order. The corporation is going slowly in the matter, but is making very definite progress.

In the discussion which followed it was brought out that the 750-hp. McIntosh & Seymour engine referred to had 22-in. cylinders without piston cooling, and was of the trunk piston type. This it was agreed was about the limit that one should go without piston cooling and without resorting to a crosshead

With reference to the merits of solid injection, it was pointed out that the Vickers Co., of England, are putting out a new engine using solid injection, and thereby saving 10 per cent of the compressor work. This engine is provided with an accumulator, and so far has shown very good results. It was agreed that forced-feed lubrication was desirable with a crosshead type of engine, although gravity feed was permissible with the trunk type. The crosshead type permitted the piston rod to pass through a stuffing-box and thus prevent the oil from becoming fouled with the gases leaking past the piston.

It was also mentioned that less trouble is experienced from a high-sulphur oil in a two-cycle engine than in a four-cycle, because of the absence of exhaust valves in the former.

The building of a large hydraulic electric power plant at the mouth of the Chelan River is now regarded as almost certain. Great Northern officials have been spending several days at Lake Chelan looking over the final details preparatory to the installation of the plant. However, no definite announcements have been made as to when this work will be commenced. The Great Northern was ready to build this plant at the time the United States went to war. It is proposed to build a 200-ft. dam 25 feet high at the point where the Chelan River flows out of the lake, thus raising the entire level of the lake. Between 40,000 and 50,000 hp. is to be developed at first and a total of 100,000 hp. is said to be available.

It is said that salt water infiltration in some oil wells in Louisiana amounts to as much as 40 per cent and affects a considerable portion of the Homer field, and that some wells have stopped flowing and others have been pinched in. Water thus far affects those wells in the deep sand and in a southeasterly direction from fault line which cuts diagonally through the Homer field from the northeast to the southwest. Wells to the northwest of the fault line in shallow sand, it is asserted, have not been affected and are expected to be of much longer life than those in deep sand.

GOVT REPORT:
EXCESS OF IMPORTS OF PETROLEUM OVER EXPORTS MORE THAN 4,000,000 BARRELS MONTHLY.
AMERICA GREATEST PRODUCER OF PETROLEUM IN THE WORLD

SOMETHING TO THINK ABOUT

Personals

Joseph C. Reagan, who has been superintendent of the Trumbull Electric Manufacturing Co., Plainville, Conn., for the last three years, has severed his connections with that company.

Harry Streik, who was erecting engineer for Frick Co., the world's largest manufacturer of ice-making machinery, for twenty-seven years, is now superintendent of the new Russ Bros. plant at Harrisburg, Penn., which he designed and erected himself.

John E. Hubbell, counsellor at law and solicitor of patents, formerly of Chambers & Hubbell, Philadelphia, announces that he has opened offices at 469 Fifth Ave., New York City, where his practice will be devoted exclusively to patent and trademark matters.

Louis R. Chadwick, hitherto branch office manager of the Sullivan Machinery Co. at Spokane, Wash., has been appointed manager of the company's branch at 30 Church St., New York City. Robert T. Banks, who has been the company's sales engineer at its El Paso (Texas) office for several years, has been appointed manager at Spokane to succeed Mr. Chadwick.

J. W. Ledoux, who has been connected with the American Pipe and Construction Co., since July, 1891, has resigned to engage exclusively in consulting engineering on his own account, at 112 North Broad St., Philadelphia. His practice will embrace designs, supervision of construction, valuation, rate-making, arbitrations, etc., particularly on water works and water-power lines.

George L. Washington, of the negotiation division of the Westinghouse Electric International Co., has left East Pittsburgh for Cuba, where he will be located as salesman in the Havana office of the company. Mr. Washington entered the employ of the export department of the Westinghouse Co. in May, 1917, after completing the college graduate apprentice course. In September, 1917, he entered the service and was discharged Jan. 28, 1919, when upon his return he was placed on order work in the International company, and in May was transferred to the negotiation division.

R. H. Ballard, president of the National Electric Light Association, left Los Angeles on Jan. 11 for another tour of the East in the interests of the organization, and to perfect arrangements for the convention of 1920, which will be held in Pasadena, Calif., May 18-21. At San Francisco he was joined by John A. Britton, chairman of the Public Policy Committee, who accompanied him on his trip. They were given a complimentary dinner by the Electrical Development League of that city on Jan. 12, which was attended by the prominent electrical men of central California. Much enthusiasm was expressed concerning the convention and plans were outlined for the work preparatory to the convention which will be carried on during Mr. Ballard's absence. On his way East Mr. Ballard will attend meetings at various places, and will attend several company sections before his return home.

Engineering Affairs

The Material Handling Machinery Manufacturers' Association has found it necessary to change the date of its open convention in New York City at the Waldorf-Astoria hotel from Jan 29-30 to Feb. 26-27.

The Mohawk Valley Engineers' Club was organized on Jan. 7, at a dinner given at the Hotel Utica, Utica, N. Y., at which about 125 engineers, architects and chemists were gathered. The membership includes civil, chemical, electrical, mechanical, mining, textile, heating and ventilating, automotive and all technical engineers and architects. Regular meetings will be held on the first Tuesday of each month and special meetings at intermediate times. The officers for the first year are: President, Byron E. White, engineer of Utica Gas and Electric Co.; first vice president, Hubert E. Collins, consulting engineer; second vice president, Roy F. Hall, division engineer, State Highway Department; third vice president, Horace B. Sweet, consulting engineer; secretary, F. E. Beck, engineer of Consolidated Water Co.; treasurer, Clifford Lewis, Jr., civil engineer. The territory embraced by the activities of the club includes a radius of 40 miles from Utica, and it is expected the membership will reach above the 200 mark.

Business Items

The Industrial Engineering Co. is now located in its new quarters at 1536 Arcade Building, St. Louis, Mo.

The Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, Mo., announces the opening of its Eastern sales office at 60 Broadway, New York City, with George D. Pogue as Eastern sales agent and Stanley Wright, assistant.

The Green Fuel Economizer Co., Beacon, N. Y., announces the opening of its own office at 1006 Finance Building, Philadelphia, in charge of W. F. Wurster, assisted by G. E. Kille. The company was formerly represented in this territory by the Baker-Dunbar-Allen Co.

The Ohio Body and Blower Co., a newly formed corporation, is an outgrowth of the old and well-known Ohio Blower Co., of Cleveland. The new company has taken over three plants from the older company, providing employment for over 600 workers in 150,000 sq. ft. of floor space. The officers of the older company will assume the same standing in the new company.

The General Chemical Co. has entered into a contract with the J. G. White Engineering Corp, covering the future designing, engineering and construction work incident to improvements and extensions to existing manufacturing plants, buildings and other property, and in connection with any new projects or developments which may be undertaken from time to time. Under this arrangement the J. G. White Engineering Corp. will handle their engineering and construction work.

The G. M. C. Engineering Co., Worcester, Mass., with offices in the Graphic Arts Building, has taken over the exclusive sales of Coppus turbo-blowers in the New England States. This company is composed of several men who were formerly in the employ of the Coppus Engineering and Equipment Co. John L. Gallivan, formerly sales manager of the company, is president and treasurer of the G. M. C. Engineering Co. Howard Mason, who is consulting engineer for McCleary, Wallin & Crouse, will also act in the same capacity for this company. Its service department will be at the disposal of all who call upon it for information.

Westinghouse Electric International Co. has recently opened a new office in the Royal Bank of Canada Building in Havana. This was found necessary because of the growing use in sugar mills and other enterprises in Cuba of Westinghouse electric equipment. J. W. White, who has been located in Cuba for some time past as Westinghouse representative, will be in charge of the new office. Mr. White's intimate knowledge of, and close relation with, the industries in Cuba peculiarly fit him to cope with all the problems that may be encountered. He will be assisted by other special engineers. A complete stock of catalogs and other descriptive matter will be maintained in the new office, where for the asking can be obtained complete information on everything electric.

Trade Catalogs

The Cutter Co., Philadelphia, Penn., has just issued a new handbook of the I-T-E circuit-breaker. This is a handsome cloth-bound book of 352 pages, 6 x 9 in. It illustrates and describes many of the largest or most significant circuit-breaker installations in the country and is of more than passing interest to the consulting engineer and to those responsible for the successful operation of important electrical plants. Applications, if approved, will be filled in the order of their receipt, if made upon the applicant's business letterhead.

"Westinghouse Opportunities for Technical Graduates" is the title of a 32-page illustrated pamphlet recently issued by the Westinghouse Electric and Manufacturing Co. This booklet describes in considerable detail the plan that has been developed by this company for the training of the graduates of technical schools at all of its various works. In it is included a list of prominent Westinghouse men who originally entered the company as graduate students, as well as a complete list of schools from which over 5,000 students have entered the employ of the company. Copies of the booklet will be sent to anyone interested, on application to the Educational Department of the company at East Pittsburgh.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$8.20@$8.65
Stove	8.45@ 9.05
Chestnut	8.55@ 9.05
Pea	7.05@ 7.40
Buckwheat	3.60@ 3.80
Rice	2.30@ 2.50
Barley	1.25

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2.85@$3.35	$3.15@$3.60
F.o.b. Philadelphia, gross tons	5.05@ 5.60	5.35@ 5.90
F.o.b. New York, gross tons	5.40@ 5.95	5.75@ 6.25
Alongside Boston (water coal), gross tons	7.00@ 7.75	7.60@ 8.00

Pocahontas and New River are practically off the market for coastwise shipment, but are quoted at $6.25@$7.00.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports are as follows:

Anthracite

	Company Coal
Broken	$7.80@$8.25
Egg	8.20@ 8.65
Stove	8.45@ 9.05
Chestnut	8.55@ 9.05
Pea	7.05@ 7.40
Buckwheat	5.15
Rice	4.50
Barley	4.85
Boiler	4.85

Bituminous

Government prices at mines:	Spot
South Fork (best)	$3.25@$3.50
Cambria (best)	3.00@ 3.25
Cambria (ordinary)	2.60@ 2.90
Clearfield (best)	3.00@ 3.25
Clearfield (ordinary)	2.60@ 2.90
Reynoldsville	2.85@ 2.90
Quemahoning	3.25@ 3.50
Somerset (medium)	3.00@ 3.25
Somerset (poor)	2.50@ 2.75
Western Maryland	2.50@ 2.75
Fairmont	2.25@ 2.50
Latrobe	2.60@ 2.90
Greensburg	2.75@ 3.00
Westmoreland ¾ in.	3.40@ 3.50
Westmoreland run-of-mine	2.75@ 3.00

PHILADELPHIA—Bituminous coal prices vary according to district from which they are mined. For ordinary slack the price is $2.45@$2.55; lump, $3.00@$3.35, at the mines.

BUFFALO—

Anthracite

	On Cars, Gross Ton	At Curb, Net Ton
Grate	$8.55	$10.80
Egg	8.80	10.65
Stove	9.00	10.85
Chestnut	9.10	10.85
Pea	7.75	9.30
Buckwheat	5.70	7.75

Bituminous

Allegheny Valley	$4.80
Pittsburgh	4.65
No. 8 Lump	4.65
Mine Run	4.80
Slack	4.10
Smokeless	4.60
Pennsylvania Smithing	5.70

CLEVELAND—Prices of coal per net ton delivered in Cleveland are:

Anthracite

Egg	$12.25@$12.40
Chestnut	12.50@ 12.70
Grate	12.25@ 12.40
Stove	12.40@ 12.60

Pocahontas

Mine-run	$7.50

Domestic Bituminous

West Virginia split	$8.50
No. 8 Pittsburgh	$6.60@ 6.90
Masillon lump	8.25@ 8.50
Coshocton lump	7.15

Steam Coal

No. 6 slack	$5.25@$5.50
No. 8 slack	5.10@ 5.50
Youghiogheny slack	5.25@ 5.50
No. 8 ¾ in.	5.70@ 6.00
No. 6 mine-run	5.25@ 5.50
No. 8 mine-run	5.75

Only coal available is mine-run Pocahontas.

MIDDLE WEST—Chicago quotations. F.o.b. cars at mine:

	Springfield, Carterville, Williamson, Franklin, Saline, Harrisburg	Fulton, Peoria	Grundy, La Salle, Bureau, Will
Lump	$2.55@$2.70	$2.95@$3.10	$3.25@$3.40
Washed	2.75@ 2.90	.....	3.45@ 3.60
Mine run	2.35@ 2.50	2.75@ 2.90	3.00@ 3.15
Screenings	2.05@ 2.20	2.35@ 2.50	2.75@ 2.90

New Construction

PROPOSED WORK

Me., Portland—J. C. and J. H. Stevens, Archts., 187 Middle St., will soon receive bids for the construction of a 4 story manufacturing building on Forest Ave. for A. S. Hinds, West St. A low pressure steam heating system will be installed in same. Total estimated cost, $500,000.

R. I., Providence—C. H. Lockwood, Archt., 171 Westminister St., will receive bids for the construction of a 1 story, 96 x 320 ft. service station on Reservoir Ave. for the Federal Truck Sales Co. of Rhode Island, 276 West Exch. St. A steam heating system will be installed in same. Total estimated cost, $100,000.

R. I., Westerly—F. P. Sheldon & Sons, Engrs., 1008 Hospital Trust Bldg., Providence, plan to construct plant additions, including a 4 story, 106 x 108 ft. mill, 1 story, 150 x 350 ft. weave shed and a 1 story, 120 x 120 ft. warehouse, on Mechanic St., for the Lorraine Mfg. Co., 547 Mineral Springs Ave., Pawtucket. Steam heating systems will be installed in same. Total estimated cost, $300,000.

N. Y., Albany—John D. Keeler, c/o Warren & Wetmore, Archs., 10 East 47th St., New York City, is having plans prepared for the construction of a 14 story hotel on B'way and Maiden Lane. A steam heating system will be installed in same.

N. Y., Brooklyn—W. Higginson, Archt., 18 East 40th St., New York City, will soon award the contract for the construction of two factory buildings, one 5 story, 75 x 140 ft., and other 1 story, 25 x 125 ft., a 2 story, 45 x 50 ft. garage and a 1 story, 25 x 50 ft. boiler house, for the Amer. Safety Razor Co., 303 Jay St. A steam heating system will be installed in same.

N. Y., Brooklyn—The Kings Co. Hospital, Clarkson St., is having plans prepared for altering existing hospital buildings and for the construction of an addition to same. A steam heating system will be installed in same. Total estimated cost, $3,000,000. Helmle & Corbett, 189 Montague St., Archts. and Engrs.

N. Y., Carthage—The West End Paper Co., West End Ave., Carthage Sulphide Pulp & Paper Co., Front St., Carthage Tissue Paper Co., Ryther & Prinyle Mfg., machinists, Carthage Machine Co., and others, owning power rights here, plan to construct a large central power station which will yield 18-20,000 hp.

N. Y., Dunkirk—The Niagara & Erie Power Co., Lamphere St., plans to construct a second 3 ph. 60,000 volt transmission line from here to Athol Springs substation.

N. Y., New York—Clinton & Russell, Archts. and Engrs., 32 Liberty St., are preparing plans for the construction of a 108 x 115 ft. office building from 38th-39th Sts., near 5th Ave. A steam heating system will be installed in same. Total estimated cost, $2,225,000. Owner's name withheld.

N. Y., New York—The New York Edison Co., Irving Pl., will soon award the contract for the construction of a 3 story, 45 x 75 ft. transformer station at 421-423 East 6th St. Estimated cost, $60,000. W. Whitehill, 32 Union Sq., Engr. Noted July 1.

N. Y., New York—D. Wortman, Arch. and Engr., 114 East 28th St., will receive bids about Feb. 15 for the construction of a 9 story, 50 x 100 ft. storage building at 108-110 West 107th St., for the Chelsea Fireproof Storage Warehouse, Inc., 426 West 26th St. A steam heating system will be installed in same. Total estimated cost, $125,000.

N. Y., Phelps—The Wilson Canning Co., Mexico, plans to construct a factory, warehouse and separate office building, here. Two 100 hp. boilers, transmission equipment, etc., will be installed in same. Total estimated cost, $15,000 to $18,000.

N. Y., Rochester—The city will soon award the contract for the construction of a 3 story, 304 x 321 ft. Junior High School at Wilson Park. An indirect radiation system, including boilers, engines, etc., will be installed in same. Total estimated cost, $1,500,000. Address J. M. Tracy, Supt. of Pub. School Bldgs. Edwin S. Gordon, c/o Gordon & Madden, Sibley Block, Arch.

N. Y., Rye—J. E. Bowman, Hotel Biltmore, New York City, has awarded the contract for the construction of a club and hotel building, here, to George A. Fuller, 175 5th Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

N. Y., Schenectady—The Genl. Electric Co., River Rd., has engaged Harris & Richards, Archs., Drexel Bldg., Philadelphia, to prepare plans for the construction of a 6 story, 50 x 200 ft. office building. A steam heating system will be installed in same. Total estimated cost, $300,000.

N. Y., Syracuse—The Syracuse Washing Machine Co., 507 East Water St., will soon award the contract for the construction of a 4 story, 200 x 250 ft. washing machine factory, including an 80 x 100 ft. moving picture auditorium for employes, on Main St. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

N. Y., Watertown—The Brier Hill Electric Light & Power Co., Inc., St. Lawrence Co., plans to construct 4 mi. of high tension transmission line from here to Brier Hill. Estimated cost, $32,000.

N. J., Bayonne—The Knights of Columbus, Star of the Sea Council, c/o G. A. McCabe, Arch. and Engr., 96 5th Ave., New York City, is having plans prepared for the construction of a club house on Ave. C. A steam heating system will be installed in same. Total estimated cost, $250,000.

N. J., Verona (Montclair P. O.)—The Eagle Rock Mfg. Co. is having plans prepared for the construction of a 2 story, 40 x 350 ft. factory, for the manufacture of moving picture films. A steam heating system will be installed in same. Total estimated cost, $250,000. Lockwood, Green & Co., 101 Park Ave., New York City, Archs. and Engrs.

Pa., Allentown—The Immanuel Evangelical Congregation plans to build a 12 story, 50 x 100 ft. church on Main St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Pa., Chester—C. W. Brazer, Arch. and Engr., 1133 B'way, New York City, will receive bids about May 1 for the construction of a 1 story church on 8th and Butler Sts., for the Trinity Methodist Episcopal Church. A steam heating system will be installed in same. Total estimated cost, $100,000.

Pa., Chester—The Frohn & Robb Association, Archs., will receive bids about May 1 for the construction of a church for the First Presbyterian Church. A steam heating system will be installed in same. Total estimated cost, $125,000.

Pa., Media—C. W. Brazer, Arch. and Engr., 1133 B'way, New York City, will receive bids about May 1 for the construction of an office and bank building for the Media Title & Trust Co., 11 South St. A steam heating system will be installed in same. Total estimated cost, $300,000.

Pa., Philadelphia—G. Edwin Braumbaugh, Arch., Real Estate Trust Bldg., will receive bids until Feb. 15 for the construction of a 1 story, 34 x 120 ft. market house at 1430 South St., for Robert Venturi & Bros., 1430 South St. A steam heating system and a refrigerating plant will be installed in same.

Pa., Philadelphia—The Chestnut Hill Hospital, 8815 Germantown Ave., engaged J. P. Simms, Arch., 1627 Sansom St., to prepare plans for the construction of a hospital in Chestnut Hill. A steam heating system will be installed in same. Total estimated cost, $100,000.

Pa., Philadelphia—H. B. Weldon, Arch., Fuller Bldg., is preparing plans for the construction of a 1 and 2 story, 40 x 160 and 25 x 160 ft. sales and service building for L. J. Kolb, 901 North Broad St. A steam heating system will be installed in same. Total estimated cost, $50,000.

Pa., Pittsburgh—The Mellon Natl. Bank, 514 Smithfield St., is having plans prepared for the construction of a 4 story, 120 x 130 ft. bank and office building on Smithfield St. between 5th Ave. and Olive St. A steam heating system will be installed in same. Trowbridge & Livingston, 527 5th Ave., New York City, Archs. and Engrs.

Pa., Plains (Wilkes-Barre P. O.)—The Plains School Bd. will receive bids until Feb. 23 for the construction of a 2 story, 70 x 130 ft. school on Moffitt St. A steam heating system will be installed in same. Total estimated cost, $150,000. Austin Rielly, Bennett Bldg., Wilkes-Barre, Arch.

Pa., Scranton—The Scranton Dress Co., South Webster Ave., will receive bids until Feb. 20 for the construction of a 3 story, 100 x 125 ft. dress factory on South Webster and Hickory Sts. A steam heating system and electric power will be installed in same. Total estimated cost, $150,000. F. W. Borgenicht, Pres.

Pa., Scranton—The Ahavath Sholem Congregation, Providence (Scranton P. O.), plans to build a 15 story 50 x 100 ft. synagogue on North Main Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Pa., Scranton—O. D. Dewitt Auto Co., Wyoming Ave., is preparing plans for the construction of a 2 story, 90 x 170 ft. garage on Wyoming Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Pa., Wilkes-Barre—The State and Luzerne Co. are having plans prepared by T. H. Atherton, Arch., Coal Exch. Bldg., for the construction of a 4 story, 90 x 100 ft. armory on Market St., along the Susquehanna River. A steam heating system will be installed in same. Total estimated cost, $350,000.

Pa., Wilkes-Barre.—Geo. Gildersleeve, Gildersleeve St., will soon award the contract for the construction of a 2 story, 45 x 225 ft. garage on South Main St. A steam heating system and electric power will be installed in same. Total estimated cost, $100,000. Thomas Atherton, Jr., Coal Exch. Bldg., Arch.

Pa., Wilkes-Barre—George S. Welch, Arch., Coal Exch. Bldg., will receive bids until Feb. 24 for the construction of a 3 story, 200 x 225 ft. silk mill for the Duplan Silk Corp. A steam heating system and electric power will be installed in same. Total estimated cost, $500,000.

Pa., Yeadon—S. L. Baraumbaugh, Hanison Bldg., Philadelphia, has engaged Jesse T. Hoekstro, Arch., 1713 Sansom St., to prepare plans for the construction of a 1 story ice plant at Presser Park. Estimated cost, $10,000.

Md., Baltimore—David Garrett & Sons, 1210 Bouldin St., are having plans prepared for the construction of a 1 story, 37 x 75 ft. boiler house and a 1 story, 65 x 65 ft. garage on East Ave. near Ellwood St. Total estimated cost, $35,000. F. Thomas, 135 North Kenwood St., Arch.

Md., Fairfield (Baltimore P. O.)—The Globe Shipbuilding & Dry Dock Co. of Maryland, Fidelity Bldg., Baltimore, is having plans prepared for the construction of a 1 and 2 story shipbuilding and ship repair plant along the water front. Contract for auxiliary power house equipment will be sub-let. Total estimated cost, $5,000,000. B. C. Cooke, Pres.

Va., Norfolk—The Beth El Congregation, c/o Herts & Robinson, Archs., 331 Madison Ave., New York City, is having plans prepared for the construction of a synagogue. A steam heating system will be installed in same. Total estimated cost, $250,000.

Va., Roanoke—H. C. Richards, Arch., 1713 Sansom St., Philadelphia, will soon award the contract for the construction of a 3 story school, here, for the Bd. Educ. A steam heating system will be installed in same. Total estimated cost, $175,000.

N. C., Aberdeen—The Bd. Comrs. will soon award the contract for the construction of a waterworks and sewerage system. Pumping equipment includes an oil engine, deep well pumps, etc. Total estimated cost, $40,000. J. B. McCrary Constr. Co., 3rd Natl. Bank Bldg., Atlanta, Ga., Engr.

Tenn., Knoxville—The Anderson Dulin & Varnell Co. plans to construct a 10 story, 90 x 100 ft. warehouse on Gay St. A steam heating system will be installed in same. Total estimated cost, $200,000.

O., Dayton—The Delco Light Co., East 1st St., plans to construct a 2 story power plant on Keowee and Pitt Sts. Estimated cost, $75,000. A Pressler, 329 East 1st St., Engr.

O., Elyria—The Elyria Savings & Trust Co. is having preliminary plans prepared for the construction of a 12 story bank and office building on Broad and Court Sts. Three boilers will be installed in same. Total estimated cost, $1,000,000. Walker & Weeks, 1900 Euclid Ave., Cleveland, Archs. and Engrs.

Mich., Detroit—The Bd. of Water Commissioners, 232 Jefferson Ave., will receive bids until Feb 17 for the construction of the sub-structure for a low lift pumping station, involving about 24,000 lin. ft. of concrete piles and 6,000 cu. yds. of reinforced concrete. Estimated cost, $300,000 to $350,000. T. A. Leisen, Engr.

Mich., Detroit—H. S. Koppin, Breitmeyer Bldg., is having plans prepared for the construction of a 2 story, 100 x 120 ft. theatre on Catherine and St. Antoine Sts. A steam heating plan, including boiler and ventilating equipment, will be installed in same. Total estimated cost, $250,000. C. H. Crane and E. G. Kiehler, Huron Bldg., Archs.

Mich., Detroit—C. H. Miles, Miles Theatre Bldg., Griswold St., is having plans prepared for the construction of a 2 story, 120 x 163 ft. theatre on Grand River and Roosevelt Aves. Steam heating system, with forced ventilation, will be installed in same. Total estimated cost, $1,000,000.

Mich., Detroit—B. F. Mortenson, 1119 Dime Bank Bldg., has purchased a site and plans to construct a 4 story, 130 x 200 ft. commercial building on Lafayette Ave. and 6th St. Steam heating equipment will be installed in same.

Mich., Flint—The Independent Cold Storage Co., 120 West Kearsley St., plans to construct a 3 story cold storage plant on Industrial Ave. Electric power and refrigeration equipment will be installed in same. Total estimated cost, $300,000.

Mich., Kalamazoo—The Clarage Fan Co., North and Porter Sts., plans to build a 1 story, 28 x 170 ft. and 66 x 70 ft. additions to its foundry and pattern shop on North St. Electric motors to supply power will be installed in same. Total estimated cost, $100,000.

Mich., Muskegon—The Bd. Educ. is having plans prepared for the construction of a 2 story school on Acorn St. A steam heating plant, including boiler, fan, pump and ventilating system, will be installed in same. Total estimated cost, $145,000. H. H. Turner, 234 Division Ave. N., Grand Rapids, Arch.

Mich., Saginaw—The Lufkin Rule Co., Hess Ave., plans to construct a 1 story, 115 x 219 ft. factory on Hess Ave. and Prescott St. Steam heating equipment will be installed in same. Total estimated cost, $100,000. Esselstyn, Murphy & Hanford, 810 Marquette Bldg., Detroit, Archs. and Engrs.

Mich., Three Rivers—E. H. Andrews, Secy. of School Dist. No. 1, will soon award the contract for the construction of a 2 story school. A steam heating system will be installed in same. Total estimated cost, $175,000. R. A. LeRoy, 122 Pratt Blk., Kalamazoo, Arch.

Mich., Ypsilanti—H. X. Wilder, Secy. of the Bd. Educ., will receive bids until Feb. 17 for the construction of a 2 story grade school. A steam heating system will be installed in same. Total estimated cost, $150,000. Robinson & Campau, 715 Michigan Trust Bldg., Grand Rapids, Archs.

Ill., Chicago—Paul Gerhardt, Arch., 64 West Randolph St., will soon award the contract for the construction of a 1 and 2 story, 50 x 200 ft. auto sales service building on Sheridan Rd. and Irving Park Blvd., for Hampton Winston, 749 North Michigan Ave. A steam heating system will be installed in same. Total estimated cost, $100,000. The Oakland Phillips Motor Co., 931 Wilson Ave., Lessee.

Ill., Chicago—The Jackson Express & Van Co., 3611 West 22nd St., is having plans prepared for the construction of a 6 story, 75 x 175 ft. storage warehouse on Madison St. and 60th Ave. A steam heating system will be installed in same. Total estimated cost, $150,000. G. S. Kingsley, 109 North Dearborn St., Arch.

Ill., Chicago—D. S. Klafter, Arch., 64 West Randolph St., will soon award the contract for the construction of a 4 story, 50 x 125 ft. auto sales building at 2449 Michigan Ave. for C. Schmalhausen, 2448 Michigan Ave. A steam heating system will be installed in same. Total estimated cost, $150,000.

Ill., Chicago—The Monighan Machine Co., 2036 West Carroll Ave., is having plans prepared for the construction of a 110 x 504 ft. manufacturing plant on Augusta, Kilpatrick and Belleplaine Aves. A steam heating system will be installed in same. Total estimated cost, $250,000. Alfred P. Weber, 111 West Washington St., Arch.

Ill., Chicago—Henry J. Schlacks, 721 North Michigan Ave., plans to construct an 8 story, 100 x 200 ft. apartment hotel on Chestnut St. and Delaware Pl. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

Wis., Milwaukee—Cahill & Douglas, Engrs., 217 West Water St., are receiving bids for the installation of a 150 hp. high pressure tubular boiler and a 100 ft. steel stack, for the Barnett Woolen Mills Co., 200 Muskego Ave.

Wis., Tomah—The Bd. Educ. will soon award the contract for the construction of a 3 story, 50 x 80 ft. addition to the high school and a 30 x 55 ft. boiler house. Total estimated cost, $60,000. C. B. Drowatsky, Clk. H. C. Haeuser, Colby-Abbot Bldg., Milwaukee, Arch.

Minn., Hibbing—Victor L. Power, Mayor, will receive bids until March 15 for the construction of a 2 and 3 story, 200 x 300 ft. recreation building in the Central Division. A steam heating system will be installed in same. Total estimated cost, $325,000. Halstead & Sullivan, Palladio Bldg., Duluth, Archs. and Engrs.

Minn., St. Paul—The Hamline University, Snell and Capital Aves., is having plans prepared for the construction of a 3 story, 50 x 125 ft. dormitory. A steam heating system will be installed in same. Total estimated cost, $100,000. F. H. Ellerbe, Endicott Bldg., Arch.

Minn., Waseca—H. C. Gerlach, Arch., Mankato, will receive bids until Feb 17 for the construction of a 2 story, 60 x 100 ft. hospital building. A steam heating system will be installed in same. Total estimated cost, $80,000. Terry Schulte Eng. Co., Endicott Bldg., St. Paul, Engrs. Owner's name withheld.

Neb., Gering—Scotts Bluff Co. plans to construct a 3 story, 68 x 112 ft. court house. A vacuum steam heating system will be installed in same. Total estimated cost, $190,000. W. N. Bowman Co., Central Savings Bank Bldg., Denver, Colo., Archs.

Neb., Omaha—John Latenser & Sons, Archs., 632 Bee Bldg., will soon award the contract for the construction of a 3 story, 126 x 136 ft. warehouse on 8th and Jackson Sts., for Trimble Bros., 11th and Howard Sts. A steam heating system will be installed in same. Total estimated cost, $200,000.

Neb., Omaha—Clark G. Powell, 2051 Farnam St., is having plans prepared for the construction of a 4 story, 45 x 132 ft. auto supply building on 21st and Harney Sts. A steam heating system will be installed in same. Total estimated cost, $125,000 to $140,000. G. L. Fisher, 1604 City Natl. Bank Bldg., Arch.

Tex., Goose Creek—The Gulf Production Co. plans to construct 2 large electric power stations and transmission systems in the Goose Creek oil fields. Proposed plant will furnish electric power for operating the pumps of all of its wells in the field. Total estimated cost, $500,000.

Okla., Carnegie—The City Clerk will receive bids in two or three months for the construction of a 100,000 gal. surface reservoir in connection with the proposed development of a new water supply from deep wells. Air lift and motor-driven centrifugal high pressure service pumps will be installed in same. The city voted $24,000 bonds for the project. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, Engrs.

Colo., Yuma—The city will soon award the contract furnishing one steel smokestack, one 250 hp. steam engine, one 125 hp. steam engine, two 200 hp. steam boilers, two alternators d.c. to above engines, switchboard, and instruments, feedwater pumps, feedwater heater, etc. R. D. Salisbury, Denver, Engr.

Idaho, Harrison—The city plans an election to vote on $42,500 bonds for the construction of a waterworks system and installation of an electric lighting plant.

Wash., Vancouver—Rasmussen-Grace Co., Archs., Bates Bldg., Portland, Ore., will receive bids about Feb. 15 for the construction of a 2 story, 25 ton capacity, cold storage plant, here, for the Columbia Dairy Products Co. Estimated cost, $75,000.

Ore., Arlington—The city voted $15,000 bonds for the construction of a sewerage system and $5,000 for the extension of the electric light system.

Ore., Chemawa—The Supt. of Indian Schools, Box 156, received an appropriation of $15,000 from the U. S. Government, Wash., D. C., for the installation of a new heating plant at the Salem Indian Training School, here.

Ore., Fossil—The Butte Creek Land, Livestock & Lumber Co. plans to install a water system, including one 10 in. centrifugal pump, dam, etc. Total estimated cost, $5,000.

Cal., Davis—The City Trustees will soon receive bids for the construction of 2 drilled wells with 2 pumps of 500 gals. per min., operated by motors, 100,000 gal. tank on 100 ft. tower, auxiliary fire pressure pump of 1,000 gals. per min., 25 fire hydrants, and distributing system of 6 to 2 in. metal pipe. Total estimated cost, $75,000. Galloway & Markwart, First Natl. Bank Bldg., San Francisco, Engrs.

Cal., Salinas—Brown Bros. are having plans prepared for the construction of a theatre to be leased to Turner & Dahnken, San Francisco. A steam heating system will be installed in same. Total estimated cost, $125,000. A. W. Cornelius, Merchants Natl. Bank Bldg., San Francisco, Arch.

Cal., San Diego—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., and Pub. Wks. Officers, 12th Naval Dist., Timken Bldg., San Diego, will receive bids for furnishing and installing complete power plant and electric generating equipment, including distribution systems for electricity and steam, at the Marine Corps Base, here.

Cal., Whittier—The city received bids for furnishing and erecting boilers and generator as follows: Terry & Carpenter, Sterling boilers, $18,070; Murray pump, $48,893; Kerr turbine and Allis-Chalmers generator, $16,911; switchboard, $2,400; total, $81,274. Thomas Haverty Co., 8th and Maple Sts., Los Angeles, Foster boilers, $15,250; Kerr turbine and Allis-Chalmers generator, $14,800; Ludlow engine, $57,900; switchboard, $2,321; total, $90,271. This work in connection with proposed waterworks system.

Cal., Whittier—The city received bids for furnishing and erecting pump and boiler from the Byron Jackson Iron Wks., 336 East 3rd St., Los Angeles, Thomas Haverty Co., 8th and Maple Ave., Los Angeles, $8,470; C. Terry, $8,588. This work in connection with the proposed waterworks system.

Ont., Galt—The city engaged H. H. Angus, Consult. Engr., 23 River St., Toronto, to prepare plans for the installation of a central heating plant to heat the 4 buildings at the hospital, here. A by-law appropriating $30,000 for this project has been passed.

Que., Montreal—The Congregation of St. Augustine plans to build a 50 x 100 ft. church in the north end of the city. Contract for heating will be sub-let. A sum of $200,000 has been raised for this project.

Que., Sherbrooke—The Howard Pulp & Paper Co., Montreal, has purchased 9½ acres on the bank of the San Francis River and is having plans prepared for the construction of a wood pulp mill on same. A 3,500 hp. power development will be added. Total estimated cost, $750,000.

CONTRACTS AWARDED

Me., Portland.—Hannaford Bros., Commercial St., have awarded the contract for the construction of a refrigerator plant to the Landers Eng. Co., 102 Exch. St. Estimated cost, $150,000.

Conn., West Haven—The West Haven School Bd. has awarded the contract for installing a steam heating system in the proposed 2 story, 45 x 137 ft. school on Noble St. to Charles W. Neumann, West Haven.

Mass., Boston—The New England Telephone & Telegraph Co. has awarded the contract for the construction of a 3 story, 80 x 100 ft. office building on Essex St., to I. F. Woodbury & Co., Summer St. A general heating system will be installed in same. Total estimated cost, $100,000.

Mass., Fall River—The Hotel Mohican, North Main St., will build a 4 story, 48 x 120 ft. addition. A steam heating system will be installed in same. Total estimated cost, $125,000. Work will be done by day labor.

N. Y., Brooklyn—The Congregation of Bikin Cholem, Fulton St. and Shepard Ave., will build a 2 story, 50 x 85 ft. synagogue on Arlington Ave. and Bradford St. A steam heating system will be installed in same. Total estimated cost, $100,000. Work will be done by day labor.

N. Y., Brooklyn—The Lincoln Hygeia Ice Co., 95 William St., New York City, will build a 2 story, 100 x 125 ft. ice plant addition on Pacific St. and Carlton Ave. Estimated cost, $100,000. Work will be done by day labor.

N. Y., New York—The New York Telephone Co., 15 Dey St., has awarded the contract for the construction of a 4 story, 100 x 145 ft. telephone exchange on Troutman Ave. (Bronx Boro.) to Gillies & Campbell, 103 Park Ave. A steam heating system will be installed in same. Total estimated cost, $200,000. McKenzie, Voorhies & Gmelin, 1123 B'way, Archts. and Engrs.

N. Y., New York—E. J. Nathan, Jr., 128 B'way, has awarded the contract for the construction of a 2 story, 77 x 106 ft. factory and store building on 7th Ave. and 27th St., to G. Richard Davis & Co., 30 East 42nd St. A steam heating system will be installed in same. Total estimated cost, $850,000.

N. Y., New York—The Round Hill Mercantile Co., 98 Bleeker St., has awarded the contract for the construction of a 10 story office building on 19th St. and 4th Ave., to W. Crawford, 7 East 42nd St. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. Y., New York—L. K. Schwartz, 110 West 40th St., has awarded the contract for the construction of a 10 story, 41 x 98 ft. loft building at 41-43 West 28th St., to Barney-Ahlers Constr. Co., 110 West 40th St. A steam heating system will be installed in same. Total estimated cost, $250,000.

N. Y., New York—The Textile Bldg., Inc., 15 West 55th St., has awarded the contract for the construction of a 16 story, 164 x 198 ft. office building at 285-293 5th Ave., to the George Backer Constr. Co., 33 East 33rd St. A steam heating system will be installed in same. Total estimated cost, $3,000,000.

N. J., Passaic—The Passaic Cotton Mills, Brighton Ave., have awarded the contract for the construction of a 4 story, 100 x 700 ft. factory, to Fred T. Ley, 19 West 44th St., New York City. A steam heating system will be installed in same. Total estimated cost, $750,000.

N. J., Woodbridge—The Reliable Chemical Co., c/o Westinghouse, Church, Kerr & Co., Inc., Engrs., 37 Wall St., New York City, has awarded the contract for the construction of a ftcory and storage building between here and Rahway to Westinghouse, Church, Kerr & Co, Inc., 37 Wall St., New York City. A steam heating system will be installed in same. Total estimated cost, $150,000.

Penn., Chester—The Cochrane Estate has awarded the contract for the construction of an 18 story office building to Ward Bros. Constr. Co. A steam heating system will be installed in same. Total estimated cost, $450,000.

Penn., Lock Haven—The Lock Haven Trust & Safe Deposit Co., East Main St., has awarded the contract for the construction of a 1 story bank to Hoggson Bros., 485 5th Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $300,000.

Pa., Philadelphia—W. S. Barnes, 20th and Erie Sts., will build a 4 story, 100 x 300 ft. assembly building. A steam heating system will be installed in same. Total estimated cost, $200,000. Work will be done by day labor.

Penn., Philadelphia—The Crescent Ice & Coal Co., 52nd St. and Woodland Ave., has awarded the contract for the construction of a 1 story, 100 x 145 ft. ice plant on Powers Lane and Island Rd. to W. F. Koelle & Co., 26th and Oxford Sts. A steam heating system will be installed in same. Total estimated cost, $35,000.

Penn., Philadelphia—The West Philadelphia Catholic High School, 49th and Chestnut Sts., has awarded the contract for the construction of a 3 story, 49 x 125 ft. school to Doyle & Co., 1519 Sansom St. A steam heating system will be installed in same. Total estimated cost, $155,000.

Penn., Pittsburgh—Alleghany Co. has awarded the contract for installing heating, ventilating and refrigerating systems in the court house, jail and morgue to L. G. Emery Co., New Castle, at $123,329.

Va., Danville—The Riverside & Dan River Cotton Mills Co. has awarded the contract for the construction of a 4 story, 133 x 800 ft. spinning mill, to the Aberthaw Constr. Co., 27 School St., Boston, Mass. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

Va., Richmond—The Rennie Dairy Co., 7th and Leigh Sts., has awarded the contract for the construction of a 2 story, 45 x 70 ft. dairy, including cold storage rooms, on North 7th St., to J. C. Beasley, North 9th St.

Ala., Florence—The U. S. Engr.'s Office, War Dept., Wash., D. C., has awarded the contract for the installation of 2 air compressors to the Worthington Pump and Machinery Corp., 115 B'way, New York City, at $29,450.

O., Canton—The city has awarded the contract for the construction of a 1 story, 47 x 96 ft. pumping station in the North End, to Keller-Huff Co. Estimated cost, $24,900.

O., Cleveland—The Masonic Temple Bldg. Co., Rockefeller Bldg., has awarded the contract for the construction of a 6 story, 130 x 300 ft. masonic temple at 3515 Euclid Ave., to Masters & Mullen Constr. Co., Electric Bldg. Motors will be installed in same. Total estimated cost, $750,000.

O., Cleveland—The Eaton Axle Co. has awarded the contract for the construction of a 1 story, 300 x 450 ft. factory and a 40 x 80 ft. power house and heat treating building on East 140th St. and the New York Central R. R. to the Crowell-Lundoff-Little-Bicknell Co., 5716 Euclid Ave. A steam heating system, including H.R.T. boilers, will be installed in same. Total estimated cost, $600,000.

O., Cleveland—J. S. Kohn, Engineers' Bldg., has awarded the contract for the construction of a 3 story, 54 x 112 ft. show room and warehouse on East 14th St. to the Bolton Pratt Co., Columbia Bldg. A steam heating system will be installed in same. Total estimated cost, $100,000.

O., Parma—The Bd. Educ. has awarded the contract for the installation of a hot air heating system in the proposed three 1 story, 60 x 118 ft. school buildings to the Amer. Warming & Ventilating Co., Rose Bldg., Cleveland.

O., Salem—The Mullens Body Co. has awarded the contract for the construction of a factory to Stone & Webster, 120 B'way, New York City. A steam heating system will be installed in same. Total estimated cost, $500,000.

Mich., Detroit—The Stroh Products Co., 253 Elizabeth St., E., has awarded the contract for the construction of a 3 story, 22 x 85 ft. ice cream plant on Hastings and East Elizabeth Sts. to Pine & Munnicke, Marquette Bldg. Circulation pump, tanks, etc., will be installed in same.

Mich., Detroit—The Studebaker Corp., Brush and Piquette Sts., has awarded the contract for the construction of a 4 story, 200 x 250 ft. automobile factory addition to the A. J. Smith Const. Co., Campau Bldg. A steam heating system and electric motors for power will be installed in same. Total estimated cost, $300,000.

Ill., Chicago—The Boyle Ice Co., 136 West Lake St., has awarded the contract for the construction of a 1 story, 125 x 175 ft. ice plant at 855 Larrabee St. to the Menke-Thielberg Co., 139 North Clark St. A steam heating system will be installed in same. Total estimated cost, $65,000.

Ill., Chicago—The Exel Motor Truck Co., c/o Henry Raeder, Archt., 20 West Jackson Blvd., has awarded the contract for the construction of a 1 story, 350 x 500 ft. factory on Menard and Dickens Ave. to H. A. Peters Co., 19 South La Salle St. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ill., Chicago—The Bnai Abraham Zion Congregation, c/o A. L. Levy, 11 West Washington St., has awarded the contract for the construction of a 1 story, 85 x 110 ft. synagogue and a 2 story, 25 x 125 ft. community house on Washington Blvd. and Karlov Ave., to Kadeshewitz & Buchel, 1342 Independence Pl. A steam heating system will be installed in same. Total estimated cost, $225,000.

Ill., Chicago—The Shore View Hotel Co., c/o Percy Johnston, Arch., 1254 Pratt Blvd., has awarded the contract for the construction of an 8 story, 60 x 145 ft. hotel at 4910 Sheridan Rd., to Olson-Carson Co., 7417 Rhodes Ave. A steam heating system will be installed in same. Total estimated cost, $800,000.

Ill., Springfield—The Springfield Marine Bank, 114 South 6th St., has awarded the contract for the construction of a bank, to Hoggson Bros., 485 5th Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $500,000.

Minn., Hibbing—School Dist. 18 has awarded the contract for installing heating and plumbing systems in the proposed 3 story, 74 x 150 ft. addition to Ainsley School, to the Schirmer Plumbing Co., Hibbing, at $47,719.

Wis., Hartford—The city has awarded the contract for furnishing and installing stokers and soot blowers to the Combustion Engineering Co., 38 South Dearborn St., Chicago. Estimated cost, $11,725.

Wis., Rio—The city has awarded the contract for waterworks improvements, including the construction of a tank and tower, to the Wausaw Iron Works, Wausaw; well, to W. L. Thorne, Platteville; pump, to the Wisconsin Foundry Co., Madison. Total estimated cost, $30,000.

Kan., Haven—The Bd. Educ. has awarded the contract for installing heating and plumbing systems in the proposed 2 story high school to Stevens, Gill & Co., Hutchinson, at $16,375.

Kan., Galena—The city has awarded the general contract for the construction of a waterworks extension, to Ray & Son, $20,940; for installing pump equipment, to the Merkle Machinery Co., 508 Interstate Bldg., $5,958.

N. D., Milton—The city has awarded the contract for the construction of an electric light plant and equipment, to H. T. Lewis, Milton, at $6,399.

Mo., St. Louis—The Century Electric Co., 19th and Pine Sts., has awarded the contract for the construction of a factory, to Stone & Webster, 120 B'way, New York City. A steam heating system will be installed in same. Total estimated cost, $500,000.

Mo., St. Louis—The J. H. Forbes Tea & Coffee Co., 9th and Clark Sts., has awarded the contract for the construction of a 5 story, 90 x 120 ft. mercantile building at 922 Clark and 306 South 10th Sts., to S. S. Callin, Clayton. A steam heating system will be installed in same. Total estimated cost, $200,000.

Neb., Omaha—The Burgess-Nash Co., 16th and Harney Sts., has awarded the contract for the construction of an 8 story, 88 x 152 ft. department store building on 17th and Harney Sts. to James Stuart

Co., 30 Church St., New York City. A steam heating system will be installed in same. Total estimated cost, $900,000.

Mo., St. Louis—The Halwe Investment Co., 3128 Locust St., has awarded the contract for the construction of a 4 story, 90 x 120 ft. mercantile building at 2805 Locust St. to A. D. Gates Constr. Co., Chemical Bldg. Two elevators and a steam heating system will be installed in same. Total estimated cost, $250,000.

Tex., San Antonio—The San Antonio Diocese has awarded the contract for installing a heating system in the proposed 3 story, 100 x 155 ft. theological seminary near Mission Conception to Chalkley Bros., 312 Main Ave., at $12,000.

Okla., Tahlequah—The city has awarded the contract for the construction of a lighting plant to A. M. Byrnes, Fayetteville, Ark., $13,149; for the installation of steam heating system and furnishing of electric equipment to Smith & Whitney, Southwestern Life Bldg., Dallas, Tex., $59,477; distribution system to the Empire Electric Co., 419 West Okmulgee St., Muskogee, $29,200.

Idaho, Plummer—The city has awarded the contract for the construction of a 14 mi. electric transmission line from here to a connection with the line of the Washington Water Power Co. at Teko, Wash., to R. H. Mercer, Plummer, at $11,975.

NEW INSTALLATIONS IN POWER

Conn., Hartford—Hotel Garde, Asylum and High Sts., is in the market for equipment for new kitchen apparatus and refrigerating plant. F. C. Walz, 348 Trumbull St., Engr.

N. Y., Long Island City—H. R. Mallison & Co., Woolsey Ave., is in the market for power house equipment, elevator, etc.

N. Y., New York—The Amer. Gas & Electric Co., 30 Church St., is in the market for second-hand 500, 600 and 750 hp., 250 lb. B. & W. boilers, also some 750 hp. 250 lb. Sterling boilers, preferably with superheat. Address N. M. Argabute.

Pa., St. Marys—The St. Marys Electric Light Co. plans to construct about 10 mi. of 22,000 volt transmission line. W. H. Brown, Genl. Supt.

S. C., Walterboro—The Walterboro Water & Light Plant plans to install one 75 kva. direct connected engine and generator Cozart Binns, Supt.

Ga., Albany—The Georgia-Alabama Power Co. plans to construct a 10,000 hp. plant along the Flint River and 60 mi. of 45,000 volt transmission line. L. H. Hardin, Chf. Engr.

Ga., Tallapoosa—The Municipal Electric Light & Water Plant plans to install one 150 kva., and one 100 kva. generators. W. A. Melvin, Supt.

Ga., Waynesboro—The city plans to install a 250 kva., direct conected generator and construct 3 mi. of transmission line. L. J. Porter, Chf. Engr. and Supt.

Tenn., Memphis—J. J. Ross, Consult. Engr. and Contr., 380 Randolph Bldg., is in the market for one small hoisting engine either 8 x 10 or 10 x 12 ft.

O., Greenville—The Franklin Tractor Co. is in the market for seven hundred and fifty 30 hp. 4 cylinder tractor motors, 750 magnetos, 750 complete sets transmission gears, 750 pressed, split steel pulleys, or power take-off systems complete, 750 motor fans and belts, 4,000 spark plugs, 750 carburetors and 750 governors. G. Nills, Pres. and Genl. Mgr.

Ill., Biggsville—Henderson Co. Pub. Serv. Co. plans to construct a 15 mi., 33,000 volt transmission line. D. W. Lee, Mgr.

Ill., Casey—The Municipal Electric Light Plant plans to construct 5 mi. of transmission line. J. C. Pfister, Supt.

Ill., Chicago—The Lincoln Park Comrs., Clark and Center Sts., plan to build a substation. Work involves a 12,000 volt, 3 ph., 60 cycle transmission line; two 3,000 gal. 64 lb. centrifugal pumps driven by 1,800 r.p.m., 4,000 volt, 3 ph. induction motors; two 300 kva., 12,000-4,000-2,300 volt, 3 ph. transformers; one 3 ph., 4 amp., 5,000 volt series ckts; storage battery; motor generator unit; local power and lighting panels and transformers, probably large floodlighting installations and concrete post drive lighting. C. H. Shepherd, Elec. Engr.

Ill., Divernon—The Municipal Light Plant plans to install a 50 kva. direct connection generator set. J. E. Rigg, Supt.

Ill., Farmer City—The Municipal Electric Light & Power Plant plans to install one 150 hp. boiler. O. B. Osborn, Supt.

Ill., Marengo—The Marengo Pub. Serv. Co. plans to construct several miles of transmission lines. R. T. Fry, Pres.

Ill., Marshall—The Marshall Ice & Power Co. plans to construct a transmission line from here to West Union. G. C. Hallaner, Mgr.

Ill., Noble—The Noble Electric Light & Power Co. plans to install a complete 25 hp. unit and 2,300 volt transformers. H. T. Flanders, Pres. and Mgr.

Ill., Peoria—The Central Illinois Light Co., 316-20 South Jefferson Ave., plans to install a one 12,500 kva. turbo-generator. L. Owen, Supt.

Ill., Princeton—The Municipal Water & Light Dept. plans to install a 300-400 kva., 2,300 volt, 3 ph., 60 cycle, 3 wire generator with direct connection to simple engine. W. N. Remsbury, Supt.

Ill., Rankin—The Rankin Electric Light Co. plans to construct about an 11 mi. 6,600 volt transmission line from here to Bocton. Charles J. Crump, Chf. Engr.

Ill., Savanna—The Peoples Gas & Electric Co., 214 Main St., plans to install boiler and generator and sub-station equipment, also construct a 10 mi. transmission line. F. P. Bowen, Engr.

Ill., Vermont—The Vermont Municipal Electric Light Plant plans to install an oil engine and generator. P. J. Tingley, Supt.

Ill., Xenia—The Village plans to install a 25 hp. oil engine and a 20 kva. generator. N. T. Pierce, Mgr.

Kan., Long Island—The Phillips Co. Light & Power Co. plans to construct a ½ mi., 2,300 volt transmission line into the farm service. Ira C. Young, Chf. Engr.

Neb., Lindsay—The Lindsay Electric Light & Power Co. plans to complete the installation of 50 hp. units and remodelling of present building. F. W. Edwards, Mgr.

Mont., Terry—The Terry Light & Power Co. plans to install a new generating unit. A. J. Enteness, Pres. and Mgr.

Okla., Kingfisher—The Kingfisher Electric & Water Plant, City Bldg., contemplates the installation of one 500 kw. turbine generator unit. E. Fisher, Supt.

Colo., Estes Park—The Stanley Power Dept. plans to install a new water wheel and enlarge generator to 450 kva., also change the 5 mi. transmission line extending from power house to village from single ph. to a 3 ph. W. C. Humphreys, Genl. Supt.

Colo., Golden—The Jefferson Co. Power & Light Co. plans to construct 8 mi., 6,600 volt transmission line to Montdale and Evergreen. E. A. Phinney, Pres. and Mgr.

Colo., Grand Junction—The Grand Junction Electric, Gas & Mfg. Co. plans to remodel its boiler house. A. E. Anderson, Genl. Supt.

Colo., Gyssum—The Casper Schumm Electric Light & Power Co. plans to construct transmission line extensions. W. C. Schumm, Pres. and Mgr.

Colo., Peetz—The Municipal Lighting Plant plans to install a 90 hp. engine and a 60 kv. generator. E. G. Ribble, Chf. Engr.

Idaho, Weiser—The Municipal Water & Light Dept. plans to rebuild approximately 2 mi. of 4,000 volt, 3 ph. transmission line. Lyle Wood, Supt.

Ore., Portland—The Dept. of Pub. Wks. plans to install one 75 hp. electric motor at the bunkers. P. McIntosh, Purch. Agt.

Ore., Shady (Roseburg P. O.)—The Perkins Sand & Gravel Co. plans to replace electric equipment of rock crusher plant with machinery adapted to burning oil. Estimated cost, $10,000.

Ore., Tillamook—The Coast Power Co. plans to install a 1,000 kw. turbine generator. C. J. Edwards, Pres. and Mgr.

Cal., Avalon—The city plans to install one 200 kw. generator. A. B. Waddingham, City Mgr.

Cal., Tehachapi—The Municipal Electric Light Plant plans to construct a 2 mi., 11,000 volt, 3 ph. transmission line for agricultural purposes. M. P. Evans, Genl. Supt.

Ont., Guelph—The Northern Rubber Co. is in the market for a new or used motor generator, 4 kw., d.c. voltage 110, a.c. voltage 550, 3 ph. or 110 single ph., 25 cycle. A. Kennedy, Engr.

EMPLOYMENT "OPPORTUNITIES"

JOBS AND MEN—For Plant and Office: Technical, Executive, Operative and Selling—See "*Searchlight.*"

EQUIPMENT "OPPORTUNITIES"

To Buy, Sell, Rent and Exchange—Used and Surplus. New Equipment and Material—See "*Searchlight.*"

BUSINESS "OPPORTUNITIES"

OFFERED and WANTED—Contracts, Plants, Capital, Properties, Franchises, Auctions—See "*Searchlight.*"

The SEARCHLIGHT SECTION of this issue is on pages 60A to 78